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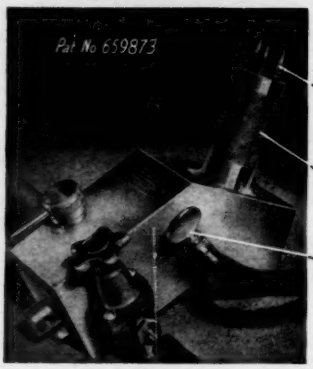

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THE PURPOSE OF UNIVERSITY EDUCATION

ALTHOUGH the importance of general education, and particularly of securing more breadth in training the scientist, or indeed any type of specialist, was emphasized at least as much at the Conference of Rectors and Vice-Chancellors of European Universities last July in Cambridge as at the subsequent meeting of the British Association at Bristol, there seems to have been little progress in suggesting means of securing it. The Cambridge Conference, indeed, noted a progressive deterioration of the balance which should exist in the universities between specialization and general culture, and a report presented to the Conference urged a stand against the current inflation of the curriculum. There was, however, little support for a preliminary year of compulsory studies of general cultural subjects, or for any system which obliged arts students to study a scientific subject and science students an arts subject for much of their university career.

At this Conference the means generally favoured were optional courses in subjects of general cultural interest, which could be taken without a subsequent examination, or a general course designed more specifically to prepare the student for his specialized courses. It was also recognized that it is desirable to deepen the student's understanding of his own special subject in the context of a wider background. This method appeared to be regarded as the most promising means of restoring the traditional balance between specialization and general culture; but the discussions seemed to lack either real unity or the note of urgency which Dr. J. Bronowski contrived to bring into his address at Bristol and Dr. Eric James into his lecture to the Science Masters' Association on "Science and Citizenship".

Perhaps more notable was the absence of any suggestion that the proper place in which breadth and general education should be acquired is in the schools. This might have been even more regrettable but for the appearance in the following month of the report of the sub-committee appointed two years ago by the Committee of Vice-Chancellors and Principals to consider and make recommendations in regard to university entrance requirements in Britain. It is clear from this report that, except for recommending that only two subjects should be required at the Advanced level of the General Certificate of Education instead of three, there is little unanimity on matters of importance to sixth-form school and first-year university teaching. Agreement on this point was indeed reached at the outset of the six meetings of the sub-committee concerned; and while the sub-committee agrees that it may be desirable to continue to require three passes at the Advanced level on the science side, the report gives little indication of the reasons for a recommendation which admittedly makes real education very difficult or even impossible for the science student. The report is, on the contrary, mainly concerned with the reasons for the divergence of views, which have produced two minority reports.

One side maintains essentially that the present requirement of prescribed subjects should be maintained, and that unless this is done the curriculum at many schools will be narrowed to subjects which are clearly utilitarian and directly vocational. It is argued that it is unrealistic to say that the schools should take full responsibility for the general education of their pupils. On the other side, it is contended that, on the contrary, no number of passes at the Ordinary level ensures the standard of general education that university teachers desire their students to possess and that, while universities and schools have a common interest in promoting a broad and liberal education side by side with appropriate specialized studies, the responsibility for general education must be taken by the schools alone.

The poor reception of this report may well be due in part to the lack of urgency and realism which seems to have characterized its proceedings. If its members had been really convinced of the importance of general education, either for the specialist or the ordinary citizen, it is difficult to believe that such relatively small points could have kept the two sides apart. There is lacking, for example, the conviction which marked the addresses of Mr. J. F. Wolfenden and of Dr. Bronowski at Bristol, or the contributions of Sir Philip Morris, Prof. N. F. Mott, Prof. F. A. Vick and Dr. A. W. Barton to the joint discussion between Sections A and L on the training of physicists (see *Nature*, October 7, p. 678). The means will be discovered when it is believed that the end really matters; and if the universities are really interested in discovering the state of the general education of their students at the time of admission, they will not be prevented from ascertaining that state even if it is necessary to devise an entirely fresh means of doing so. Mr. T. W. Holland, headmaster of Reigate Grammar School, has suggested the institution of a general paper which would ensure that the student had read widely and to some purpose, that he had gone deeply into the history and geography of another country and that he was not "scientifically illiterate".

It is clear from the report that some members at least of the sub-committee lean towards such an idea, and the discussion at Bristol on the training of physicists indicated a far greater disposition to re-examine the underlying issues, both by schools and by universities, than is apparent from the sub-committee's report. Sir Philip Morris, for example, opening the discussion, took for granted much that Mr. Wolfenden had emphasized as to the necessity of a fully educated man possessing both the deep insight into human nature that is most conveniently and comprehensively acquired from the written and printed record, and the first-hand personal experience of human actions to be gained from deep and practical immersion in human affairs, personal, social and political. He agreed, too, as to the importance of the non-scientist having some understanding of the scientist's outlook on the physical universe; indeed, as

Mr. Wolfenden had put it, in our present civilization the view that more is required than just the human without the scientific, or just the scientific without the human, was not seriously challenged in the discussion that followed.

Sir Philip Morris posed some searching questions: Should science be taught in the secondary school as separate subjects? Do scientists value the acquisition by the general citizen of an understanding of the scientific outlook sufficiently to support the diversion of effort to that end from the acquisition of new knowledge? Is the structure of postgraduate education adequate or does it, too, require re-examination? Are we relying too much on research as a means of postgraduate training and education?

A noteworthy feature of the discussion at Bristol was the evidence it provided of a readiness to re-examine first principles, to experiment with new methods and to make drastic changes if required. Prof. Mott and Prof. Vick were as ready as Sir Philip Morris not merely to ask searching and leading questions, but also to seize opportunities of experimenting with new ways. They recognize the importance of close and new ways of co-operation between school and university and realize that suggestions thrown out must be put to the test—for example, that of Prof. Mott for allowing a general paper to play a major part in determining the award of scholarships. While Prof. Mott was emphatic that general education is the responsibility of the school, and in particular that it is essential for the sixth-form scientist, there appeared to be little difference between his point of view and that of Dr. A. W. Barton, who described some of his attempts at the City of London School to assist boys to make a wise choice of their sixth-form courses. Prof. Mott believes that it is desirable that the decision to read science should be made as late as possible in a boy's time at school; and this is quite consistent with Dr. Barton's claim that the sixth-former intending to read science should be allowed to spend a major part of his time on science, for Dr. Barton's plea was based on the assumption that adequate time had previously been given to general education. Furthermore, Dr. Barton argued that the school's function is to stimulate curiosity, to develop the critical faculty and impart some understanding of the scientific attitude and method.

If this is achieved, the ordinary sixth-former should acquire exactly the basis for his general education that he needs as a citizen of this modern world, whether he follows a scientific career or not. Moreover, he will also acquire very largely the broad and general education that Prof. Mott requires as a basis for a university course. Dr. Barton's ideas, moreover, lend some support to the view argued most eloquently by Prof. Vick that it is possible to build around physics as a major component an education for future Civil servants, politicians and industrialists as deeply and widely stimulating as that provided by the 'Greats' or 'Modern Greats' of Oxford. Prof. Vick maintained that in this way we could develop, for example, intellectual courage and honesty, the ability to assess a situation, to think logically and quantitatively, and to handle abstract ideas as well as impart some understanding of the meaning of scientific proof and recognition of the limitations of science. He was as confident of the practicability of working out such courses as Prof. Mott was that the general education for the sixth-form scientist is a matter of fitting the wider studies into the curriculum and making the reward for working at them sufficiently attractive.

There is thus much more reason than the report on University Entrance Requirements itself implies for believing that the schools and the universities of Britain are ready to come together in this matter, and to contemplate even drastic changes if necessary. The addresses and discussions at Bristol have made clear to a wider audience that the educated man to-day—and even more in the next two or three decades—must have a clear understanding of the outlook and method of science. The non-scientist must possess a framework into which to fit new knowledge, a vocabulary with which to handle it, standards by which to test and to tell genuine knowledge from nonsense, just as the scientist must possess an understanding of human issues and human experience. To insist that science must become part of our culture is not indeed to argue that the scientist should have the deciding voice in local, national or international affairs: it is simply to maintain that his training must qualify him to make perfectly clear to his fellow-citizens, at all stages and at all relevant points, what will be the consequences, in scientific terms, of any decisions which are contemplated, and equally that those fellow-citizens receive an education which enables them to understand what the scientist is saying.

The educated man must thus, as Mr. Wolfenden contended, be able to move with some facility in at least two spheres. He must be able to appreciate in something like perspective the achievements of the human race, in government, literature, art and social living, and, secondly, he must be able to move with some facility in the realm of abstract ideas. It does not matter which field he finds most congenial; but Mr. Wolfenden is clearly right in holding that we should seek not to give the same kind of education to all but, recognizing the differences between people, to educate them rather according to their ability, age and aptitude.

To do this might go far to assist in the adjustments that will be called for if we are to provide, not merely the educated men and women that will be required in industry and in the government service and for the continuous acquisition and application of new knowledge, but also the ordinary citizens who are capable of taking intelligent decisions in the many affairs of local or national politics in which scientific and technical issues are involved. Those adjustments, moreover, are unlikely to be made unless the objective is recognized as fully worth while, and education is seen as an inter-related whole. Qualitatively as well as quantitatively, the provision to be made for the education of the scholar and the scientist must be considered in relation to that made for the training of the administrator and man of affairs, the tech-

nologist, the technician and the ordinary citizen whose formal education terminates at secondary school level.

What does seem to be emerging from current discussions is the recognition of the possibility that available resources may be utilized to the best advantage if there is a more general disposition to consider the wider perspective and less tendency to push sectional claims to extremes. Those who insist most strongly on the importance of a general education for the scientific specialist, or of some understanding of the outlook and achievements of science on the part of those not entering on a scientific career, are not advocating any relaxation of university standards. They are, on the contrary, suggesting that university practice and standards should be adjusted to take closer account of the advances in human thought and experience which science has made possible. It is not enough for the teaching of specific disciplines like physics and chemistry to take account of the immense advances in their own fields. The technique of teaching itself requires adjustment, and the scope of university work must have regard both to the changes in the schools and in the level of education of the adult population. Extra-mural activities like adult education need reviewing in relation to the purpose and the resources of the universities, and in relation to the impact on adult education of such new media for the communication of ideas as broadcasting and television.

This is not to suggest that the universities bear the sole or even the primary responsibility for adult education, for example. Their responsibilities in that field can be neither defined nor discharged without the co-operation and support of other bodies, or without regard to what, for example, professional institutions and local authorities are doing, any more than they can fulfil their functions in regard to the general education of their students without regard to what the schools are doing or without close co-operation with the schools. Such co-operation will become the easier and closer when we have clear ideas both of the functions which the different institutions can best fulfil and their relation to the whole task of producing an educated community. The university must indeed always bear a major responsibility in that task; but its part may be more easily seen and the more effectively played if there is kept in mind the whole ideal of the university as a community of masters and scholars in pursuit of knowledge and learning, who also form a community of men and women living together and seeking the truth, and that not in their own narrow subject alone. When we regard the university, on the contrary, as merely a scholar's workshop and laboratory, a place for students to study, teachers to teach, and the investigator to carry out research, it fails to bring to its members or to the whole community the full service and inspiration that lie within its power. The nature of the university's contribution to the training of men and women to serve the community, to the equipment of the adult citizen to meet the needs of the modern world, may well need re-examination, and also the methods used to make that contribution; but it is above all essential that we should keep in mind that supreme function of the university as a community dedicated to the search for truth and the fearless communication of ideas.

In this sense the universities can never abdicate their responsibilities for leadership in the community without endangering their own existence. It is not simply that the community looks to them to give some broad indication of the implications for human thought and living of advances in knowledge and changing technologies—of the consequences, for example, of nuclear weapons or of the development of nuclear power and the spread of television. The community needs centres of independent thought and criticism, in which the value of international interchange of thought is clearly demonstrated, just as much as it needs institutions to provide it with the fully trained and really educated men and women capable of handling alike the scientific and technical problems of government and industry and the human and social issues that are also involved, and to provide the new knowledge upon which the advance of science and technology depends. It needs chiefly, however, men and women who are both able to draw imaginatively on past human experience, and are no less competent to face the future with vision, with understanding and courage, and to fashion and create the new institutions and new loyalties that changing needs demand. If that is to be done, the creative thinking and experiment must begin within the university itself. Testing and re-shaping where necessary its own methods and institutions—but safeguarding and upholding the highest standards and traditions of university life and work—the university must seek to further the mutual understanding with the society outside its walls which is essential both to the health and sanity of society and to the continuance of the external support upon which the university itself depends.

PLANT ANATOMY RESEARCHES OF I. W. BAILEY

Contributions to Plant Anatomy

By Prof. Irving W. Bailey. Pp. xxvi + 262 + 23 plates. (Waltham, Mass.: Chronica Botanica Company, 1954.) 7.50 dollars.

THIS volume includes reprints of a few of Prof. I. W. Bailey's papers, selected mainly to illustrate how techniques from other sciences have been adapted to botanical problems and to direct attention to the value of collaboration between the sciences. After a childhood in Peru, Bailey entered Harvard, where he became instructor in forestry in 1909 and professor of anatomy in 1927. In later years his width of experience made him an invaluable adviser in forestry research and an ideal director of the reorganization of Harvard's botanical resources.

Throughout Bailey's work the problem of the origin and evolution of the Angiosperms was much in his mind and provides the link between such diverse aspects of his work as wood anatomy, floral morphology and palæobotany. To my mind his most important researches were those on the cambium, and

it is striking how many of the basic facts in botanical teaching owe their confirmation to his work. The cambium is a difficult tissue to handle, and the success of Bailey and his collaborators in solving outstanding problems is largely due to excellence of technique; it is one point to regret that he has never, to my knowledge, found it possible to give a full and precise account of his cambial techniques. The soundness of his work on the cambium is convincing, and his conclusions have stood the test of time. He was the first to establish the uninucleate condition of the long fusiform initials of the cambium in *Pinus* and to show that the same nuclear volume controls the cytoplasm of ray and fusiform initials, although the volume of the latter may be 500–1,000 times greater. The description of mitosis in pine fusiform initials is one of the most spectacular in botany, while the application of a modified vacuome technique enabled Bailey and Zirkle to demonstrate the highly vacuolated condition of these remarkable meristem cells.

A problem of tree growth which had long exercised the minds of botanists was the method of increase in number of fusiform initials in the widening cambial periphery; the precision of Bailey's technique and a comparison of a wide range of types enabled him to state that in Gymnosperms and many of the less-specialized Dicotyledons the increase is brought about by occasional, relatively transverse divisions and the elongation past one another of the products, while in the most specialized types radial longitudinal divisions occur. These studies occupied the period 1919–30; but some of Bailey's later papers on wood show his phylogenetic interests, as, for example, the consideration of the ways in which vessels have originated in Tracheophyta, with the conclusion that they have arisen independently five times, including different origins in Dicotyledons and Monocotyledons. Close study of wood anatomy in some living Gymnosperms directed attention to the importance of precise information on variability for comparison with fossil types.

Between 1934 and 1939 Bailey turned his attention to chemical and physical methods for the investigation of cell walls, collaborating with Kerr, Vestal and Berkley in different aspects of the work. Again, some of the results have become basic in teaching, such as the properties and non-cellulosic nature of the middle lamella and the distribution of lignin in the secondary wall in the interstices of the cellulosic matrix. In X-ray studies he was one of the first to elucidate some of the aspects of the structure of cellulose walls.

In floral morphology the development of clearing techniques facilitated study, and the extremely interesting type of stamen and carpel in the previously undescribed *Degeneria*, along with studies of the carpels of Winteraceae and related types, will attract carpel morphologists. On a different line, the study of myrmecophytic species of *Cecropia* provided interesting facts about feeding habits of Attine ants and led to an assessment of Schimper's teleologically based theory of myrmecophily.

A review of this book cannot omit reference to the most attractive sectional title pages, head pieces and vignettes. Inspired by Bailey's papers, Prof. B. G. L. Swamy has illustrated in this form some of the main evolutionary trends and topics discussed. Special reference must be made to the last vignette, which illustrates the evolution of tracheal elements in the form of a 'herb' diagram derived from a motif common in paintings of the Mogul School. The use of the pattern of the cross-section of the wood of a coniferous root for the cover lining is most appropriate.

This is an unusual book which should certainly find a place on botanical shelves as a guide to the work and scientific approach of one of America's greatest botanists. The volume contains a full list of Bailey's publications, and the frontispiece shows a characteristic photograph of the author.

L. I. Scott

X-RAY DIFFRACTION IN PHYSICAL AND CHEMICAL LABORATORIES

X-ray Diffraction by Polycrystalline Materials Edited by H. S. Peiser, H. P. Rooksby and Dr. A. J. C. Wilson. (Physics in Industry.) Pp. 725. (London: Institute of Physics, 1955.) 63*s*.

THIS work recently published by the Institute of Physics will certainly come to be one of the most-used volumes in X-ray laboratories. It is written for 'diffractionists'—that is, those who work with X-rays as a tool for studying the physics and chemistry of solids but not for determining structures.

It is not at all a text-book, but one for workers in the laboratory. It can only be appreciated and properly used by a man of science having already a good grounding in crystallography and in the theory of X-ray diffraction. The arguments recapitulated in the first chapter will clarify the uncertainties of a beginner but do not pretend to introduce him to the subject of crystallography.

The aim of the authors has been to outline the methods actually in use in the study of crystalline powders. First place is given to descriptions of apparatus and techniques—above all, the most recent ones. Those who may be unhappy about their own collection of literature references need no longer worry: the authors have given them all the references that may be missing and, what is best of all, a summary, both brief and clear, of all the important works which have appeared during the past twenty years. It is a remarkable feat to have presented this considerable documentation in such an attractive manner and so well laid out. For example, if a scientist has to make a study of structures at high temperatures, he can find the method that is best suited to his needs and the original references which will give him the details for the construction of apparatus.

Certain chapters are original monographs—for example, those on counters, microbeams, diagrams of organic fibres, etc. The chapters of the last part of the book, on some applications, are particularly welcome: they appear to contain the essence of many investigations. Against this must be set the fact that certain points remain but slightly developed, despite the interest they have for those concerned with the physics of the solid state: such topics are the analysis of the shape of the lines from distorted crystals, and the determination of the parameters of order in solid solutions. It must be admitted, however, that mention is made of the study of the single crystals, and it is difficult to reproach as being incomplete a book which already runs to more than seven hundred pages.

The book is the collective work of some thirty authors. Thus each topic is dealt with by a

specialist, and each author's personal experience of his subject explains the lively approach of the work. All annoying heterogeneity has been completely smoothed out by the three editors: Dr. H. Rooksby, on techniques; Dr. A. J. C. Wilson, on methods of interpretation; and Dr. H. S. Peiser, on applications. All the authors are British, and to me as a Frenchman this shows how numerous in Britain is the school of X-ray crystallographers continuing brilliantly the work of their teachers who founded this science.

A. GUINIER

ERASMUS DARWIN

The Temple of Nature; or, the Origin of Society
A Poem, with Philosophical Notes. By Erasmus Darwin. (In Russian.) Pp. 239+6 plates. (Moskva: Izdatelstvo Akademii Nauk SSSR., 1954.) 12 roubles, 80 kopecks.

IT may be that the great admiration felt for Charles Darwin in the U.S.S.R. induced the Academy of Sciences to re-publish the Russian translation of this poem of his grandfather. "The Temple of Nature", by Erasmus Darwin, was originally published in 1803, a year after his death. The original Russian translation of this poem was published in 1911 in the *Journal* of the Ministry of Education in St. Petersburg. The translator, N. A. Kholodkovsky (1858–1921), was rather a remarkable man—a professor of zoology, a poet and a gifted translator of Milton, Shakespeare, Byron and Goethe.

"The Temple of Nature" is probably less known than "The Botanic Garden" by the same author. It is a didactic-scientific poem written in pseudo-classical style in heroic couplets. It is not a major poetic work, but it is not without certain charm and is full of humour, much of it clearly unconscious. Here is a fragment of it, chosen at random:

"In earth, sea, air, around, below, above,
Life's subtle woof in Nature's loom is wove;
Points glued to points a living line extends,
Touch'd by some goad approach the bending ends;
Rings join to rings, and irritated tubes
Clasp with young lips the nutrient globes or cubes;
And urged by appetencies new select,
Imbibe, retain, digest, secrete, eject."

The translator really did a wonderful job not only in bringing out the full meaning of the poem but also in preserving the style, rhyming sequence and metre of the original. To do this he had to expand the original 1,928 lines into 2,247 lines.

In addition to the full text of the poem, the volume contains Charles Darwin's life of his grandfather in translation, two sets of notes by Erasmus Darwin, also in translation, one set by the translator and one set by the editor, who also provides a biographical sketch of the translator. There are two portraits of Erasmus Darwin, one of the translator and other illustrations.

The book is carefully edited by E. N. Pavlovsky, director of the Zoological Institute of the Academy of Sciences in Leningrad, a significant fact especially when it is realized that the translator, N. A. Kholodkovsky, was also a prominent zoologist.

The poem is an expression of Darwin's scientific views on the origin and development of life, the evolution of the mind and the growth of society. Like his "Botanic Garden", this poem is an invaluable record of scientific thought at the end of the eighteenth century. The publication of the Russian translation of this is not intended as a homage to a minor English poet, but as an important contribution to the ever-growing Russian literature relating to the history of science.

S. I. TOMKEIEFF

SYSTEMATIC ZOOLOGY

Methods and Principles of Systematic Zoology
By Ernst Mayr, Prof. E. Gorton Linsley, and Prof. Robert L. Usinger. (McGraw-Hill Publications in the Zoological Sciences.) Pp. ix+328. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 51*s*.

NOVELTY usually brings rapid developments in a science followed by a spate, sometimes super-abundant, of text-books and treatises. The novelty of the new systematics is, however, unspectacular either in methods or results, and development in taxonomy has been correspondingly slow, with the need for a comprehensive treatise growing equally slowly. The need has, however, been very acute for many years, and zoologists can count themselves fortunate that it has now been satisfied in proportion to its intensity. The three authors have brought to the task not merely the essential knowledge but also breadth of understanding and an ability for lucid and logical exposition.

The book, "a concise presentation of the methods and principles of zoological classification", is sub-divided into three parts, of which the first, and shortest, deals with the history of taxonomy and proceeds logically to consider changed concepts and the status of the hierarchical categories. Part 2, taxonomic procedure, is a step-by-step guide from advice on the selection of the problem and assembling the pertinent material and information, to the preparation of the paper describing the results, selecting its title and seeing it through the press. Much of this part is, of course, elementary; but much that is complex is made to seem elementary, not by over-simplification but by clear thinking and presentation. The phenomena the taxonomist will, or may, encounter and the methods he will, or ought to, use for dealing with them are themselves treated in taxonomic fashion and grouped in logical categories. It is a sorry comment on human frailty that nomenclature, which should be merely the handmaiden of zoologists, has so beguiled some and bedevilled others that the section dealing with it needs the equivalent of a quarter of the whole book. But that is not the fault of the book, nor of its authors, and students will find the section very useful even though the important Copenhagen Decisions (1953) were not available in time for inclusion.

"Methods and Principles" is an essential text-book for all students of evolution and taxonomy and a valuable reference book for practising systematists however experienced they may be. Much of it should be read by any zoologist who would claim to have a broad and liberal understanding of his subject. There are, naturally, some expressions of opinion that are controversial, but errors are notably few and generally insignificant. The authors will therefore find it especially galling that the statistical section, which the non-mathematically minded may follow blindly, contains a slip; the numerical value of the standard error of the difference between means (p. 142) is not an index of significance.

H. W. PARKER

THE INTERNATIONAL WOOL TEXTILE RESEARCH CONFERENCE, AUSTRALIA, 1955

WOOL is a most versatile fibre, and many facets of interest to scientists and those concerned with its growth and processing were examined at the Wool Textile Research Conference, held successively at Sydney, Geelong and Melbourne, under the chairmanship of Dr. F. W. G. White, during August 22–September 9. The Conference was promoted, with much foresight and imagination, by the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) to mark the expansion of research into the wool textile field in Australia. Never before had so many wool scientists and technologists assembled together from many countries of the world. The excellent planning and organization of the many sessions held for the presentation and discussion of papers (some 140 or so in number) ensured the success of the Conference, despite the wide range of scientific investigations that the Conference encompassed.

Many of the fifty-three overseas delegates, from Great Britain, the United States, France, Sweden, Germany, Japan, India, South Africa, Canada and New Zealand, attended by invitation of the Australian Government, and all would wish to express their appreciation of the hospitality received from both organizations and private individuals during this memorable occasion.

In addition to the scientific sessions, tours of the Sydney–Geelong region were organized so that delegates could learn at first hand of wool-growing, pastoral improvement, and irrigation in Australia.

Wool research under the Commonwealth Scientific and Industrial Research Organization has rapidly expanded in recent years, chemistry and biochemistry being directed by Dr. F. G. Lennox at Melbourne, physics and engineering by Dr. Burgmann at Sydney and technical development by Dr. M. Lipson at Geelong; reference should also be made to the McMaster Animal Health Laboratory at Glebe, Sydney, the Sheep Biology Laboratory at Prospect, the Animal Health Research Laboratory at Parkville, and other stations of the Organization and university departments. Some hundred delegates attended from these institutes. The overseas visitors were able to see the work in progress, which included amino-acid and peptide analysis, the study of crimp and other physical properties of fibres, and a new approach to solvent-scouring of wool. Australian workers contributed more than fifty papers, while those from abroad included twenty from the Wool Industries Research Association of Torridon, Leeds, eighteen from the University of Leeds, nine from other delegates from Britain, thirteen from the United States, and twenty-three from other countries.

Several lectures, some to the delegates and scientific observers from universities and research centres and others open to the general public, were given during the Conference period. The public lectures each attracted an audience of five to six hundred, and this, together with other evidence, clearly indicated the public recognition of the contribution of the Commonwealth Scientific and Industrial Research Organization to the service of the community. The inaugural lecture at the Conference was given by Prof. W. T. Astbury, of the University of Leeds, who, in his own inimitable style, showed how early work on the structure of keratin fibres and materials had stimulated much of present-day thought and research on proteins. Dr. E. G. Carter, of the International Wool Secretariat, gave an excellent account of the part played by science in the study and use of wool to a large public audience at the University of Melbourne. Perhaps the most stimulating lectures, however, were those given by Prof. Robert B. Corey, Dr. F. Sanger and Prof. Emil L. Smith. Many of the overseas delegates had previously heard lectures from these investigators, but it is certain that even these delegates were again thrilled to hear a first-hand account of the masterly researches of Corey and Pauling on the configuration of the proteins, of Sanger on the structure of insulin, and of Smith on structure determinations of papain. Everyone present appreciated the significance of Sanger's statement that the molecular weight of insulin is 5733.

In addition to these Conference lectures, many delegates addressed local societies and other groups interested in scientific and technical advances in the use of wool. There was, in fact, a wide exchange of opinions and information and there is little doubt that many opportunities were taken to co-ordinate research between different countries.

It is impossible within reasonable space to give a detailed account of all the papers presented at the Conference; but a useful purpose will be served by giving, for each of the main sciences, the outstanding features, with special reference to new work, that were made available either by a single paper or by a group of contributions. Some idea of the amount of material made available to the Conference will be gained by the anticipated size of the Conference Proceedings, to be published in the near future, namely, more than 2,000 pages that will occupy five or six volumes.

Chemistry

In the chemical studies, the emphasis was understandably on proteins. Dr. F. Sanger (University of Cambridge), in addition to describing the investigations carried out by his team of research workers on the distribution of the cystine residues in insulin, with special reference to the cyclic structure formed by intramolecular dithio linking, discussed cysteic acid peptides formed by oxidation and subsequent partial hydrolysis of wool; paper ionophoresis under high voltage indicates a very complex mixture in which serine– and glutamic acid–cysteic acid peptides predominate. Researches on the enzyme papain, parallel in many ways with those of Sanger and co-workers on insulin, were reported by Prof. Emil Smith. The crystalline protein and also its mercuric derivative have been studied and much of the amino-acid sequence has been elucidated. One interesting feature of this work is that, of the eight sulphur atoms present in the molecule, only six can be accounted for as cystine or cysteine and, in this connexion, it should be noted that in wool only 85–86 per cent of the total sulphur appears to be present as cystine–sulphur, due, according to Dr.

D. H. Simmonds (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne), to the presence of 14–15 per cent of elementary sulphur. This latter finding was reported in a paper by Simmonds in which were given complete amino-acid analyses for four samples of wool fibre.

The availability of a complete amino-acid analysis for wool would mark the end of the first stage in the study of the keratin molecule. Unfortunately, there are several problems to be resolved with regard to the data available. Simmonds's data agree reasonably well with those of Dr. A. Robson and M. C. Corfield (Wool Industries Research Association, Leeds), which were also reported to the Conference; but there are differences in the values for certain of the amino-acids that appear to be outside the tolerance of accuracy of the analytical methods used. In addition, the content of some amino-acids clearly differs with different wools; this is undoubtedly true of cystine and tyrosine, and possibly occurs with phenylalanine, glycine, aspartic acid and threonine. The data available account for 96 per cent (Simmonds) to 99 per cent (Robson and Corfield) of the total nitrogen, and hence the unknown sulphur fraction must exist as elementary sulphur—a theory not readily acceptable to most protein chemists—or to the presence of a polysulphide group in place of the cystine–dithio linkage.

Many papers were concerned with the constitution of the keratin molecule. Dr. S. Blackburn and G. R. Lee (Wool Industries Research Association, Leeds) reported that the method of hydrazinolysis of Akabori *et al.* shows glycine, alanine, serine and threonine to be carboxyl terminal groups in intact wool. Most workers in this field, however, are concerned with the obvious heterogeneity of the wool fibre and have attempted to separate, either from the whole fibre or some histological fraction, for example, cortical cells, a soluble protein or protein degradation product. Experiments in this direction, carried out by means of thioglycollic acid, were described by Dr. F. G. Lennox and by J. M. Gillespie (both of the C.S.I.R.O. Wool Textile Research Laboratory, Melbourne), while Dr. P. Alexander and Dr. L. F. Smith (Chester Beatty Research Institute, London) claimed that oxidative fission, achieved by peracetic acid followed by extraction with aqueous ammonia, affords products of a lower degree of peptide-chain degradation. I. J. O'Donnell and E. F. Woods (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) reported a comparison between the reductive and oxidative methods, and Dr. B. S. Harrap (of the same Laboratory) examined some of these preparations for molecular weight by the spreading monolayer technique; for α-keratose he obtains values ranging from 7,500 to 70,000 depending on the *p*H and ionic strength of the solvent. Prof. H. Zahn and J. Meienhofer (University of Heidelberg) obtained products, which they call wool gelatin, by extraction of wool with cold water; but there is some doubt as to the wool keratin being the direct source of their material. The bearing of the nature of soluble protein material from wool on the regeneration of wool fibres was discussed by Dr. F. Happey (Bradford Technical College).

Much attention was given to the reactivity of the disulphide bonds in proteins and peptides. Alkaline treatment of wool results in formation of lanthionine, and this reaction was discussed by Prof. A. Schöberl and Annemarie Wagner (Veterinary School, Hamburg), by Prof. H. Zahn, and by Dr. S. Blackburn and G. R. Lee (Wool Industries Research Association, Leeds); these workers described a method for the determination of lanthionine based on the spectral absorption of the ninhydrin colour, whereas Dr. E. O. P. Thompson (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) resorted to bromine oxidation. The separation of the diastereoisomerides of lanthionine was described by Schöberl and Wagner and by Blackburn and Lee. The mechanism of the formation of lanthionine and the preparation and properties of derivatives of lanthionine were given in papers by Zahn and by Dr. J. M. Swan and co-workers (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne).

The attention that has been given to the extraction products of high molecular weight and to the products of partial hydrolysis was reflected in the papers devoted to their separation. Thus Dr. R. L. M. Synge (Rowett Research Institute, Aberdeen) discussed the separation of larger peptides and advanced considerations that merit serious study, while the paper by Dr. A. J. P. Martin (National Institute for Medical Research, London) on the partition chromatography of proteins was a valuable contribution to this subject; in this connexion, Dr. Sanger recommended the use of paper ionophoresis at high voltages for use with peptides.

A fuller utilization of wool has been developed by chemical treatment of the fibre; this was shown by papers on this subject, especially those by Prof. J. B. Speakman and his co-workers of the University of Leeds, who gave a series of papers describing investigations on the chemical mechanism of permanent set, on cross-linking by the use of formaldehyde and of ninhydrin, and on the setting of stained fibres at low temperatures. Prof. Zahn, in a lecture to the Conference, described the use of mono- and bi-functional cross-linking agents and their effect on the resistance of the fibre to degradative processes, and a paper by J. E. Moore and Dr. H. P. Lundgren (U.S. Department of Agriculture) referred to dimaleimides as cross-linking agents. Prof. M. Oku and I. Shimizu (Kobe University, Japan) claimed that the stability and mechanical properties of wool are improved by formaldehyde cross-linking, achieved by treatment with hexamethylenetetramine.

A new approach to the chemical modification of the wool fibre was shown by Wikström and co-workers (Swedish Textile Research Institute, Gothenburg), who found that the surface reactivity of the fibre could be increased by treatment with chemical reagents, especially hydroxyl ions and organic solvents; it is of interest to note that W. G. Crewther (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) noted in his paper that hydroxyl ions increase the susceptibility of wool fibres to proteolytic attack. A paper of practical importance in the shrink-proofing of wool, given by R. Bentham, C. B. Stevens and Prof. C. S. Whewell (University of Leeds), dealt with the action of hypochlorites on wool that had been modified by treatment with alkalis, acids, deaminating agents and dyes. All these contributions place emphasis on the part played by the cuticular layers of the wool fibre in chemical processes.

The general trend of work on the chemical modification was well exemplified in a lecture by Dr. H. P. Lundgren, who discussed the stability of the hydrogen-bonded wool structure, as shown by the reaction with β-propiolactone, the stability of the disulphide bonds, the behaviour of wool on heating or exposing to ultra-violet light and the protection

of wool against such agents by the use of, for example, titanium alkoxides; one interesting observation in this lecture was that the yellowing of wool is promoted by suint, one active principle of which is urocanic acid (a glyoxalylacrylic acid).

Physics

The application of reaction-rate theory of visco-plasticity to wool was the subject of a lecture by Prof. H. Eyring (University of Utah) and of one of the physics sessions. This theory often merely expresses the usual experimental results in an alternative form, but a stimulating paper by Dr. L. Peters (University of Leeds) attempted to relate the statistical parameters to a molecular model of the fibre. The interaction of wool and water again brought reaction-rates to the fore, and some beautiful experimental work from the C.S.I.R.O. Wool Textile Research Laboratory at Sydney provided data for the very rapid diffusion of water into single fibres. A paper by F. L. Warburton (Wool Industries Research Association, Leeds) showed how useful the wet-bulb theory could be for calculations of drying and conditioning on an industrial scale.

A review of the present position of research on worsted spinning was contributed by J. Ingham (Wool Industries Research Association, Leeds), and Dr. Margaret Hannah (University of Leeds) discussed problems of high-draft spinning. This session also considered woollen carding and spinning and the design of experiments when industrial plant has to be used. Fibre arrangement and the behaviour of fibres during mechanical processing were surveyed in a series of papers presented by British and Australian delegates. Wet processes, together with dyeing and finishing, were discussed in three sessions, the most interesting development being the solvent scouring system used at Geelong. Much information was also made available on the degradation of wool during wet processing, and the full report of the Conference should provide manufacturers with an excellent guide to precautions that are necessary when subjecting wool to acid or alkaline conditions. The sessions on manufacturing processes were concluded by a symposium at Geelong with some four hundred members of the local textile industry, where a lively discussion followed short addresses by Dr. A. B. D. Cassie, Dr. J. G. Martindale and Prof. C. S. Whewell.

Histology

The fine histology of wool and the recent discovery of its bilateral structure provided much material for exchange of experience and opinion. There seems little doubt that the bilateral structure contributes largely to the crimp of wool, and because of the different reactions of the two structures to swelling, it may well be a principal factor in maintaining the bulkiness, and therefore the warmth, of wool fabrics. Although much was discussed about the wool follicle and its blood supply, no suggestion was made as to how this difference in keratinization, apart from references to Auber's work on detailed segmental keratinization, or possibly even in chemical composition, might arise. The histology of the wool fibre and that of its follicle are subjects that require much more research, possibly with entirely new approaches. The fine structure of wool is slowly being revealed by the electron microscope, and infra-red absorption spectra coupled with deuteration of the protein chains not locked in crystallites offer opportunities for considerable advance in our knowledge of wool structure. It must be remembered, however, that although the crystallographers may solve the problem of the crystal structure of keratin, they will have thrown only a little light on how wool works. The contributions by Dr. R. D. B. Fraser (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) and by G. King (Wool Industries Research Association, Leeds) on the infra-red spectra of swollen fibres were, therefore, most welcome.

There were also sessions on wool as a textile fibre, where students of genetics and nutrition sought guidance from the physicists and chemists on the fibre characteristics desired by the wool manufacturer. These discussions revealed again the uncertainty that exists concerning the uniformity of the physical and chemical properties of wool; and until greater accuracy is attained in such measurements, the biologist can only seek greater regularity of length, diameter and crimp. Many of the difficulties facing the physicist and chemist in finding variations in the properties of wool are probably due to the heterogeneous samples that normally come their way, and one outcome of the Conference has been the establishment of contacts that will provide wool samples from flocks of a definite type of sheep, or even from different parts of one or more fleeces: in this connexion, a scheme has been proposed for the preparation of, for example, large samples of finely cut, clean wools so that workers all over the world may have a common source of material for amino-acid analysis, etc.

As a final note, it is appropriate to consider the Conference in its wider perspective, made possible by the numerous and long-distance tours that the delegates, either individuals or in parties, were able to make during their stay in Australia. Here was a vast expanse of land, much of it scrub and with large tracts of uncultivatable soil. Yet to-day approximately 127 million Australian sheep are producing more than 1,200 million lb. of greasy wool, 74 per cent of which is merino. This is merely a reflexion of the strength and endeavour of the Australian people who, as described in the Conference Handbook, "live in a dynamic economy". Since the introduction at the end of the eighteenth century of the first merinos into Australia and Tasmania, the land has been cleared and the pasture improved in order to raise such an immense number of the descendants of the original small stock. The arduous task of developing the refractory land was first achieved by the early settler, but to-day the Australian Mutual Provident Society is organizing and financing land clearance on a large scale. Terrain capable of feeding one-half or less sheep per acre is improved to levels of two or more per acre. This improved pasturage has been made possible by the work of the Commonwealth Scientific and Industrial Research Organization, which has investigated the vital questions of soil fertilization, selection of grasses, clovers, etc., the problems of metal deficiency in soils, and the many factors in the breeding and care of sheep.

Irrigation also presents a serious problem in a country where the rainfall is generally meagre and irregular. The delegates saw vast areas in Victoria and South Australia where there was serious flooding and where, in the summer months to come, the land

will be dry and parched. Extensive schemes of irrigation and water conservation have been carried out or are nearing completion, and delegates had the opportunity of appreciating the magnitude of these schemes by visits to the Snowy Mountains and to dams under construction, such as that at Warragamba.

To-day there are stud farms where the merino stock is maintained, and the delegates were able to visit such studs near Deniliquin and those in the Macquarie Valley region in Tasmania, where a very pure strain of fine-woolled merinos is maintained. Research on genetics and growth of sheep by the Commonwealth Scientific and Industrial Research Organization has been most active. The occurrence of 'steely wool' and malnutrition of the sheep was traced to cobalt deficiency. The wide need for phosphate fertilization of the soil was demonstrated, and to-day problems such as 'staggers' due to *Phalaris tuberosa* are being investigated.

The people of Australia in general and the graziers in particular have come to appreciate the invaluable work of the Commonwealth Scientific and Industrial Research Organization, and the importance of the Conference to Australia was indicated by the presence of the Prime Minister and several colleagues at the inaugural dinner, and by the reception of all delegates by the Governor-General and Lady Slim at Canberra.

A. B. D. Cassie
F. O. Howitt

SOIL MECHANICS, GEOLOGY AND CIVIL ENGINEERING

DURING the recent meeting at Bristol of the British Association, a most informative joint meeting between Section C (Geology) and Section G (Engineering) took the form of a symposium to discuss the interdependence of geology, civil engineering and the new science of soil mechanics. Mr. F. H. Edmunds, of the Geological Survey of Great Britain, introduced the discussion. He pointed out that the civil engineer, in order to make an appreciation of the likely reactions of the rocks to his activities, requires as full geological information as possible concerning a new site, particularly in regard to the physical characteristics of rocks as determined from small samples (their hardness, cohesion, porosity of the rock); the arrangement of rock masses and strata at an engineering site (whether they lie horizontally or are inclined or buckled or folded, etc.); and the potentialities of water storage in, and movement through, the rocks. Detailed geological information is more necessary to-day than in former years for two main reasons: through advances in technique and machinery, many civil engineering works of to-day are immensely larger and more complex than those of past days; and whereas the old engineers usually had the choice of site, present-day works often have to be constructed at sites imposed on the engineer. These may be on alluvial tracts, in coastal areas, or in other difficult situations where the ground is occupied by thick beds of unconsolidated material, in many instances saturated with water.

Up to thirty years ago, geological science had more or less ignored petrological studies of soft sediments. The physical characteristics of soft rocks and, in the case of clays, differences of behaviour relative to the variable factor of the amount of adsorbed water in them, had received scant notice; but these points are of vital importance to engineers. In the circumstances, engineers and physicists set out themselves to get information of the kind required. From their work has evolved the science of 'soil mechanics'.

The word 'soil' in this connexion connotes soft unconsolidated material irrespective of its thickness or of its depth below ground surface; it has but little connexion with the top several inches of the earth's crust associated with agriculture. Generally speaking, what the engineer calls 'soils' are the 'soft rocks' of geological terminology, for example, sand and clay. Their essential feature, however, is lack of consolidation.

Much of soil mechanics investigations is a matter of physics undertaken in the laboratory, but laboratory tests by themselves are incomplete. To obtain the fullest information from them the small samples used need to be related to the stratigraphy of the beds from which they are taken.

Mr. P. L. Capper, of University College, London, described the fundamentals of soil mechanics. Soil—used in the engineering sense—necessarily forms, in its natural condition, the foundation for all works of construction, except where these can be founded directly upon solid rock. It is also used extensively as a constructional material, for example, in embankments, dams and earth roads. In designing any members of an engineering structure, four points have to be considered: the load or external forces applied to the member; the internal forces and stresses set up in the member; the deformations produced; and the way in which failure will take place if the member is overloaded. The same applies to soil; but compared with other materials of construction, soil presents greater difficulties on account of its lack of uniformity and its susceptibility to changes in its properties arising from variation in the water content. Soil mechanics comprises three main divisions: mechanics of soils, that is, the loss of equilibrium induced by engineering work, stress distribution and movement of water in soil; site investigation and the testing of soil for the determination of the relevant properties; the application of the findings under the first two headings for civil engineering design and construction.

The first division of soil mechanics includes the study of the conditions of stability of masses of soil, the determination of the internal stresses set up in soil under the action of external and gravitational forces and study of the laws governing the movement of water in soil. As with other engineering materials, the solution of stability and stress-distribution problems in soil involves an application of statics combined with assumptions as to deformation characteristics such as elasticity or plasticity.

In deciding upon the depth to which an investigation should be carried out, the chief point is to estimate the depth of soil which will be appreciably affected by the applied loads, and this depends upon the extent of the loaded area. The concept of the bulb of pressure illustrates this principle. The most important soil properties from the engineer's point of

view are compressibility, shear strength and permeability. The compressibility of soil, in the broadest sense of the word, may be defined as the relation between compressive deformation and the pressure producing it. The deformation may result from one or more of the following factors: it may be elastic, recoverable when the pressure is removed; plastic, due to plastic flow of material; or may result from consolidation or closer packing of the particles resulting from the expulsion of water. In clay soils the settlement due to consolidation may be of considerable magnitude but is a very gradual process.

The shear strength of soil is assumed to be made up of two components: intergranular friction and cohesion. Generally speaking, sands and gravels derive their strength almost entirely from friction, whereas in clay soils cohesion predominates.

Reviewing the rapid development of soil mechanics, it is seen that a vast amount of knowledge, theoretical and practical, has been accumulated in a comparatively short period of time. If this knowledge is to be used to the best advantage in civil engineering, careful study must be made of 'case history', that is, observation of engineering works during construction and while in ordinary use. Also, every opportunity should be taken of investigating thoroughly any failures which are attributable to the soil. Soil mechanics is not, and never can be, an exact science, and its successful application always calls for experience and common sense.

Two papers on direct applications of soil mechanics and geology to civil engineering followed, delivered respectively by Mr. A. H. Toms, of the Civil Engineer's Department, British Railways, Southern Region, and by Mr. D. F. C. Henry, of the University of Leeds.

It was not until about 1937–38 that the scientific study of the physical and engineering properties of soils was taken up by one or two selected civil engineers of British Railways with the view of obtaining better understanding of the many landslips and other soils problems with which British Railways are faced. In the case of landslips, calculation, taking into account the mechanics of the slipping masses, the water pressures and the resistances offered by the soil, now often enables a far more rational approach to be made to the remedial measures than was possible before the advent of the science of soil mechanics.

The biggest single landslip problem affecting British Railways is that of the coastal landslips of the Folkestone Warren, Kent. There the railway runs for two miles continuously across a great expanse of slipped chalk and Gault clay resulting not from a lubricated surface between the Chalk and the Gault as formerly assumed, but from shear failure of the Gault in its basement bed on top of the Lower Greensand. The Middle and Lower Chalk form cliffs rising to + 550 ft. O.D. behind the wide stretch of slipped ground, while the Gault underlies the whole of the affected area. In 1938, research was commenced into the nature of the slips, which were then once again beginning to threaten the stability of the railway. Test boreholes were sunk over a wide area down to depths of 300 ft. and many soil samples were extracted for visual inspection and special testing. In this work fossil identification and the recognition of stratigraphical horizons by the geologist proved of the utmost value in supplementing the information obtained from soil mechanics tests.

As a result of the research at the Warren, an extensive programme of stabilization works has been put in hand consisting of: (1) new sea walls farther out to sea, with filling behind protected by concrete slabs in order to provide toe weight on the foreshore; (2) drainage of water out of the slips by means of a new tunnel heading; (3) overhaul of all existing drainage headings and groynes; and (4) repair to old groynes and provision of new ones.

It has been found by experience that in many cases of substation buildings, signal boxes and bridges the design of the foundations is determined, not by the shear strength of the ground but by its consolidation settlement under the load. One of the most difficult problems which arises in connexion with the estimation of the probable settlement of structures is that in which a group of piles may be required to transmit the foundation load to a layer of soft compressible soil, the thickness of which is too great to permit the piles to penetrate to firmer material below. Nevertheless, it has proved possible to arrive at reasoned estimates of probable settlements in such cases, a typical one being that of proposed pile groups for new side spans to the Kingsferry Bridge over the Swale, where there is a great depth of soft alluvium overlying London Clay of varying strength.

Typical of the application of soil mechanics to the solution of tunnel stability problems is the case of Bo-peep Tunnel, Hastings. This double-lined tunnel passes through the Wadhurst Clay. A few years ago it was noticed that the tracks near the western end of the tunnel were rising, the side walls were closing in and houses over the top started to subside. Steps were taken at once to put temporary supports in the tunnel to arrest the movement. Very careful investigations revealed that the movements were due to shear failure of the ground in the side-wall footings. This had been brought about by very slow progressive softening of the ground under the tracks on account of the combined action of percolating water and the dynamic effects of rail traffic.

Following this instance, extensive soil mechanics investigations were made in both Hastings and Ore tunnels, and major strengthening works were put in hand.

Mr. Henry described some soil mechanics aspects of the design of pad, strip and raft foundations located on the surface of the ground or at a relatively shallow depth. Recent experimental investigations include those of Golder, who in 1941 carried out tests on axially loaded model footings ranging in size from 6 in. × 6 in. to 30 in. × 6 in. on the surface of clean dry river sand contained in a 3 ft. 6 in. × 3 ft. 6 in. × 14 in. deep box.[1] Tests were also carried out on footings ranging from 3 in. × 3 in. to 18 in. × 3 in. on remoulded London Clay in a 2 ft. 6 in. × 1 ft. 8 in. × 8 in. deep box. Meyerhoff made some tests on footings on sand contained in a box with a glass front; the inside of the glass was smoked so that the movements of the grains under load were automatically scribed on the glass. In another series of tests, vertical and eccentric loads were applied on footings of various lengths and 1 in. wide on the surface of, and at shallow depths in, loose and medium Ham River sand and remoulded London Clay.

More experimental evidence based on larger footings tested on the surface of, and at a depth in, sand and clay and loaded with axial and eccentric loads is desirable. In planning tests, the elimination of restraint due to confinement of the soil is necessary, and the results must be carefully analysed in the light of what is known concerning the behaviour of soils under stress and the modes of failures of footings.

Mr. Henry concluded that the present position of soil mechanics aspects of foundation design is reasonably satisfactory. Where soil conditions are straightforward or the structure is not large—for example, a domestic house or a small retaining wall—then simple investigations of the site and tests coupled with elementary soil mechanics theories are sufficient for practical work. On the other hand, considerable practical experience and theoretical knowledge is required where soil conditions beneath projected important structures are complex, and the interpretations of investigations and recommendations are best placed in the hands of specialists.

The engineer will never be able to escape the fact that soil is the most variable material with which he has to deal, and even where a mass of soil is apparently of uniform type, its physical properties may vary considerably. Apart from general changes in physical properties which may occur across a site, there are innumerable local variations which would entail much work to determine and take into account directly. In suitable cases such local variations can be catered for in the design of important structures by means of a coefficient of variation, in the nature of a factor of safety, based on the magnitude and frequency of properties revealed by soil mechanics tests.

The symposium was attended by a large audience and admirably exemplified the value of joint meetings between sections, a feature that becomes yearly more desirable with the rapidly increasing degree of interdigitation of the different sciences. Interest in the meeting was accentuated by the kindness of *Engineering* in providing pre-prints of the several papers, and of the Soil Mechanics Department of the University of Bristol in furnishing apparatus for purposes of demonstration. F. H. EDMUNDS

LIGHTING AND VISION

THE discussion on lighting and vision in Section I (Physiology) of the British Association during the recent Bristol meeting was opened by four speakers whose papers dealt with some important aspects of the subject.

In the first paper, H. C. Weston, director of the Medical Research Council's Group for Research in Occupational Optics, gave a brief account of some of the studies of human responses to varieties of lighting that have been made in recent decades with the object of providing scientific knowledge as a basis for planning lighting, particularly for building interiors. A number of these studies which have influenced present concepts of good lighting practice have been made in Great Britain, under the ægis of the Medical Research Council and the Department for Scientific and Industrial Research. They were primarily prompted by concern for the welfare of people at work and for their occupational efficiency.

Thus, in the early twenties, Elton, Weston and Wyatt each studied the effects of lighting upon the performance of weavers, which was shown to vary with the amount of illumination available up to about 30 lm./ft.^{2}. Weston and Taylor varied the illumination provided for printing compositors, and found that the rate and accuracy of working was proportional to the logarithm of the illumination value up to a level of 25 lm./ft.^{2}. They also showed that if the lamps used were so placed as to be glaring, work was impeded and the effectiveness of a given value of illumination on the work was reduced.

McDermott determined the desirable illumination for the work of typists, and Adams studied the response of persons doing visually unexacting work under different conditions of lighting. By such field-studies in occupations, chosen because their visual demands seem typical of whole classes of occupations, it was hoped to determine a scale of values of illumination adequate on physiological and psychological grounds for diverse purposes. This is a lengthy and difficult procedure, and a more fundamental approach was suggested by Beuttell in 1933. Pointing out that the visibility of all objects depends on certain of their characteristics, chiefly their size, contrast and luminance, he proposed that the relations between these variables be ascertained experimentally, so that levels of illumination could be computed for any visual task the critical components of which could be measured.

Using a suitable series of standardized tasks, Weston determined these basic relations, and his data are widely used internationally in prescribing illumination for good visual performance. He has also shown the effect of age upon the performance of these visual tasks and how it varies with different levels of illumination.

A much studied aspect of lighting is glare. Current rules of practice for the avoidance of this evil are due largely to the experimental studies of Stiles and, more recently, of Hopkinson and others at the Building Research Station. Responses to a variety of other features of lighting have been and still are being studied scientifically. Although recent advances in knowledge of lighting requirements, as well as in lighting techniques, are being applied fairly extensively, there is no doubt that the present lighting of many homes, schools, hospitals, offices, factories and other places is poor; not very rarely it is almost incredibly bad.

The investigations described by W. R. Stevens, head of the Illumination Group, General Electric Company's Research Laboratories, Wembley, were made by Foxell and Stevens to explore the dependence of the capacity for seeing detail upon the luminance of the object looked at and the luminance of fields of different size surrounding the object. Lythgoe (1932) showed that, except at low values of test-object luminance, the visual acuity attainable is better when the surrounding field of view has a luminance not very much below that of the test-object than when this field has zero or almost zero luminance.

On the basis of this finding, it has been widely held that lighting for good seeing should brighten the whole apparent environment almost as much as it brightens the given object of attention. However, Lythgoe did not study the effect upon acuity of luminous surrounds of test-objects when the surrounds do not entirely fill the visual field. Foxell and Stevens have done this, and have also measured acuity at higher values of luminance than Lythgoe used. They made, altogether, about 100,000 observations, using a Landolt broken ring as test-object. The ring was presented in contrast with a central field subtending an angle of 0·5° at the eyes of the

observers. The luminance of this field was varied up to a value of 10,000 ft. L. Visual acuity was measured with the remainder of the visual field dark and also when the small central field was surrounded with a more extensive bright field. Measurements were made using three such surrounds the angular subtense of which was, respectively, 6°, 38° and 120°. The effect of the bright surround was studied when its luminance was made either equal to or different from the luminance of the central field.

It was found that at low luminances of the central field, visual acuity was unaffected by the size and luminance of the surround except, as Lythgoe also found, that it was reduced when the surround luminance exceeded that of the detail to be detected. At all luminances of the central field exceeding 1 ft. L., the presence of a luminous surround improved acuity, and the best effect was observed when the central field and the surround were matched in luminance. The beneficial effect of a bright surround upon acuity was not significantly greater with surround sizes of 38° and 120° than with the 6° size. Although this comparatively small luminous surround suffices for the achievement of high acuity, in ordinary circumstances a general distribution of light is usually necessary in buildings because detail has to be seen in many positions.

Foxell and Stevens found that maximum acuity was reached at a central field luminance of about 1,000 ft. L., with a 6° surround of equal luminance. At higher levels of luminance and for all surround conditions, acuity decreased. Some experiments were also made with equal-luminance red–green combinations of test-object and central field to determine the acuity due to colour contrast. Quite high values of acuity were attained, but the maximum was inferior to that reached with a high-contrast neutral test-object.

In his contribution, dealing with some effects of filament and of fluorescent lighting on visual performance, Dr. W. F. Floyd, senior lecturer in physiology, Middlesex Hospital Medical School, London, presented the results of a number of tests applied to clerical workers subjected to these forms of lighting alternately. Among the questions which have been posed concerning fluorescent lighting, that of its efficiency as a visual stimulus is one to which an answer is of particular interest to large employers of labour, who must provide artificial lighting on a large scale. Another question is what, if any, is the effect of the usually unnoticeable cyclic variation in light output of fluorescent lamps? Dr. Floyd's investigations were primarily intended to find an answer to these two questions.

Dr. Floyd first made an experiment with twenty-two persons of normal sight, who performed Weston's speed of visual discrimination test illuminated to 10 lm./ft.^{2} alternately by filament lamps and by fluorescent lamps. The mean performance of the subjects under each illuminant did not differ significantly. Multiple tests of a similar kind were then performed by another group under 6 lm./ft.^{2} of filament lighting and also under 6 lm./ft.^{2} of fluorescent lighting; again there was no significant difference between the respective mean performances. In another experiment, seventeen persons were exposed to lighting which was automatically and instantaneously changed from filament to fluorescent at intervals of a few seconds. The filament lighting provided a fixed illumination, but the illumination given by the fluorescent lamps could be varied by the subjects, who were asked to match it to the filament lighting for 'equal comfort'. The mean level of fluorescent lighting chosen in this way was slightly higher than the control level, although the difference was physiologically insignificant.

So as to make a long-term comparison between filament and fluorescent lighting, three comparable groups of clerical workers carried out their normal daily work, interspersed with various tests of performance and of certain visual functions, for thirteen weeks under three forms of lighting. One group had filament lighting, another had fluorescent lighting operated by an a.c. power supply and the third group had d.c.-operated fluorescent lighting free from cyclic variations. The working illumination in each office was standardized at 12 lm./ft.^{2}. None of the tests applied to the three groups afforded any evidence that the three forms of lighting had different effects. Thus, from all these experiments, it appears that, for equal illumination, visual performance is just as good under fluorescent lighting, with or without 'flicker', as it is under filament lighting.

Discussing the lighting of streets and vehicles, J. G. Holmes, technical director of Holophane, Ltd., pointed out that its function is to give road users confidence in their visual impressions as trustworthy guides to action. In a suitable state of adaptation, the sensitivity of the eye to light is remarkable; but, while very low illumination may enable familiar objects to be recognized fairly quickly, the rapid recognition of unfamiliar and unexpected objects, which is often essential for the safety of road users at night, requires much better illumination. An almost instantaneous assessment of the quickly changing scene confronting both pedestrian and vehicle driver has to be made and suitable motor responses initiated.

Under modern conditions in busy traffic areas, there is a bewildering variety of lights, among which those intended to give vital information or warning to road users sometimes lack conspicuity or add to the general confusion. The essential information should be given clearly with the right emphasis, and misleading information must be avoided. The variety of suitable colours and shapes of road signal lights seems now to be exhausted, hence the recent recourse to flashing lights so as to achieve conspicuity.

There is a tendency to increase the power of lights to gain attention to them, but this device also increases dazzle. An example is the red 'stop' lights on numerous modern cars. Some of these are of 100 candelas or more, and this is out of proportion to the general level of street lighting. They appear with shattering suddenness, often only a few yards in front of a following vehicle driver, and they tend to promote irritation and strain rather than visual confidence. Flashing beacons at pedestrian crossings give a welcome and timely warning of the need for special care; but where a number of them are visible at multiple road junctions they are disconcerting if out of step. Flashing car-direction lights take longer to interpret than semaphore indicators.

Mr. Holmes directed attention to the importance of siting street lamps so as to define the direction of roads unambiguously and to reveal the presence of roundabouts and centre reservations. Although improved street lighting tends to encourage greater traffic density and somewhat higher vehicle speeds, there is some statistical evidence that the night

accident-rate is reduced, and there is no doubt that it increases the confidence of road users. As to the question of yellow versus white headlamps, careful experiments have led to the conclusion that, for equal beam intensity, there is no significant difference in revealing power nor in estimates of glare, and it is not true that yellow light penetrates fog better than white.

The general discussion evoked by the papers which have been summarized was confined to the subjects of fluorescent and of street and vehicle lighting. The chairman, Dr. R. S. Creed, mentioned that difficulty in reading meniscus gauges under fluorescent lighting was within his knowledge, although this may have been due simply to misplacement of the lights. Dr. Floyd pointed out that lamps of different colour temperature give different colour-rendering and, occasionally, a critical contrast might be weakened by the light from one type of lamp although not by another. He had investigated a variety of complaints against fluorescent lighting, but they were often expressions of dissatisfaction with other conditions, or they were due to conditions of lighting not necessarily produced by using fluorescent lamps. In reply to speakers who asked whether ocular ill-effects resulted from long-term exposure to fluorescent lighting, Mr. Weston said that there is no evidence of this. There had been a few cases of ocular affections occurring soon after a change from filament to fluorescent lighting, and those affected had wrongly blamed the lighting; he mentioned one such case which was demonstrably due to a bacterial infection. When, as now, many changes to fluorescent lighting are taking place, it would be surprising if there were no merely coincidental occurrences of ocular troubles. From his own investigations, he could confirm Dr. Floyd's conclusion that complaints against fluorescent lighting often proved to have a different basis. Referring to flashing beacons at pedestrian crossings, a speaker thought it unfortunate that they do not adequately illuminate anyone using or waiting to use the crossing. As to the red 'stop' lights on cars, another speaker claimed that experiments have demonstrated that these should be of 50 candelas for seeing at a distance of 50 yards when a driver is dazzled by opposing headlights.

GENETICS AND PLANT BREEDING

A JOINT session at Bristol of Sections K (Botany) and M (Agriculture) of the British Association was devoted to a symposium on "Genetics and Plant Breeding". The range of contributions to the symposium emphasized not only the scientific bases of present-day plant-breeding programmes, but also the dependence of advanced communities on a constant, integrated attack on those limiting factors to yield and quality which can be overcome by the genetical approach to crop improvement. A guaranteed standard of living, which advanced peoples have come to regard as a birthright, and which is now recognized as an international responsibility so far as the less-developed peoples are concerned, demands maximum efficiency from the germ plasm in food production. Not only must crop plants produce maximum yields at economic levels, but also quality, variety and long-term reliability of the material in the face of epidemics and environmental variations must also be among their attributes. The interaction of food production and soil fertility over large areas of the world presents grievous problems which can only be solved satisfactorily by escaping from an exhaustive form of monoculture to a rotational culture based on species of plants yet to be isolated from Nature's repertoire. If it is to continue to serve advanced communities, the science of plant-breeding has to respond quickly to human progress in all directions, in changes of dietary needs, in advances in agronomy, in farm mechanization as well as in the grading and processing of the final product.

Dr. D. Lewis, of the John Innes Horticultural Institution, Bayfordbury, in his opening paper, suggested how genetics, although unable to produce plants to order, can offer a systematic approach towards such problems and possibilities by initially 'blue printing' the foundation genotypes as well as outlining methods whereby a desired genetic architecture can be constructed stepwise. The limits to the construction of gene recombinations are frequently set by close linkage, involving gene effects with opposing or compensating functions. The eventual attainment of genotypes as near as possible to the ideal often depends on the breakdown of these linked units of inheritance. This problem is one with which crop-improvement projects are constantly being faced, and reliable methods such as a temporary passage through a tetraploid condition or the application of physical environmental stresses at meiosis might profitably be perfected to achieve an immediate and permanent release of undesirable gene combinations. Similarly, the breakdown of the natural breeding system of a species can often aid materially in releasing variability as well as in ensuring reliability of cropping. Thus in cherries, mutations induced by X-rays have yielded fully self-fertile genotypes which crop well even under adverse conditions for pollination by insects.

The importance of the part played by the breeding system in controlling variability and therefore in deciding the genetical approach to its improvement is nowhere better exemplified than in the genus *Rubus*, which was surveyed by Dr. G. M. Haskell (John Innes Horticultural Institution, Bayfordbury). Here apomixis is widespread, but in some instances variations in the mechanism allow of segregation and recombination among maternal chromosomes. Such sub-sexual processes give rise to greater variability than is often realized, and selection becomes possible. The segregation of quantitative characters within the sub-sexual apomict *R. nitidioides* (Merton Early) indicates that the improvement of economic characters such as earliness and intensity of prickles is possible, though the speed of selection will necessarily be slower than in fully sexual groups. Many apomictic species are also polyploids of various kinds, and a complete change to sexuality may reveal an unbalance characteristic of some polyploid groups. Thus in the *Eubatus* section of *Rubus*, broadly divisible into the mainly tetraploid group *Moriferi veri*, and the *Corylifolii*, which are largely pentaploid and are descended from the apomictic *R. caesius*, apomixis is widespread; whereas in the section *Idaeobatus*, consisting predominantly

of diploid species, sexual reproduction is normal. The breeding behaviour of both inter- and intra-group hybrids is therefore often complicated, and only the most thorough study of joint segregations of groups of characters will ensure the detection of sexual progeny from the sub-sexuals and the apomicts. It is through such investigations on breeding behaviour and on the genomic constitution of species and varieties that the breeder can make full use of all the variability potential of his material.

Among the most helpful genetic concepts in plant breeding that have been developed in recent years are those elaborated by Prof. K. Mather in his studies on variability, in which variation is classified as free or potential. In homozygotes, all the variability is free and, discounting mutation, it is in a fixed state. If the breeding system allows, populations of homozygotes possessing maximum immediate fitness will be developed. Heterozygotes, however, contain potential variation which can only be freed at meiosis in sexual reproduction. Where the number of heterozygous loci is large, and where close linkage preserves gene combinations in a heterozygous condition, as it inevitably must in many cases, the problems of freeing the potential variation in heterozygous material become very real. Dr. A. J. Bateman (Christie Hospital and Holt Radium Institute, Manchester) emphasized that the upper limits of selection are governed by the methods that are used to realize the potential store of variability in heterozygotes. Using methods designed to exhaust the genetic potential, notions on the selection limits of certain characters in living organisms often have to be radically revised. This has been clearly demonstrated in laboratory experiments on *Drosophila* and the mouse, while in Nature it has become expensively obvious in another direction among the parasitic Basidiomycete fungi. Such laboratory and natural successes from new releases of variability underline the need for studying every aspect of plant-breeding procedure to ensure that crop improvement programmes shall not be allowed to rest on what well may turn out to be false selection limits.

One successful method of transcending selection limits has been the utilization of heterosis both in animals and plants. It is consistent with many aspects of the historical growth of science to find that immense benefits have followed the practical use of heterotic hybrids in food production, while we are still debating the nature of the precise genetic mechanism underlying the phenomenon. Mr. Watkin Williams (John Innes Horticultural Institution, Bayfordbury) developed a theme from which it could only be concluded that it was unnecessary and undesirable to partition heterosis into mutational euheterosis, balanced euheterosis, and luxuriance, after the scheme of evolutionists—notably Dobzhansky. Although it seems likely that the underlying genetic mechanisms controlling vigour are essentially the same in all these artificial categories, it does not follow that heterosis is always governed exclusively by any one mechanism in any given organism. Indeed, this is most unlikely, if only from analogy with the numerous mechanisms that are known to control discontinuous variation. The question of deciding between the two main theories of heterosis, namely, dominance with linkage as against the over-dominance theory, has hitherto presented an insoluble problem. However, the failure of certain selection procedures in the American hybrid maize programme indicates that the dominance hypothesis alone is insufficient to explain all the facts, while data on the biochemistry of heterozygotes, such as those of Pauling and Irwin, indicate the physiological mechanisms through which overdominance could operate. Thus an exclusive approach to heterosis is at present to be avoided, if maximum utilization is to be made of the various mechanisms which govern quantitative variation.

In no field of crop improvement is the basic approach so important as in selecting for resistance to disease. The breakdown in resistance which we have come to expect following the release of new varieties on a commercial scale has raised doubts in many minds as to whether the interplay between host and parasite can be settled in favour of the host. Dr. Lewis, from a survey of the literature, has concluded that genetic control seems more likely with insect pests than with fungal disease where chemical control appears to be more effective. An important consideration in this connexion was contained in a contribution by Dr. R. L. Knight (East Malling Research Station), in which it was suggested that the ease with which parasites form biological races may be correlated with a simple genetic mechanism controlling resistance in the host. Resistance based only on a few major genes may be more easily circumvented by a single mutation in the parasite. Complex resistances based on major genes, and reinforced by modifiers and polygenes introduced from a wide range of material, are on the contrary much less likely to be overcome by biological specialization in the parasite. The manipulation of complex resistances of this nature has been successfully accomplished with the cotton variety, Sudan Sakel, which is susceptible to attack by jassids. Here a bridging genotype had to be synthesized by back-crossing, to give a modified Sakel which in turn was used as the recurrent parent for the intensification of resistance through further transferences of polygenes affecting length and density of epidermal hairs. The scanning of a genus or of a species for sources of resistance involves the acquisition of a wide collection of genotypes from both wild and cultivated sources, and the maintenance of a large and expensive genetic museum of material. Nevertheless, in genera such as *Solanum* and *Gossypium*, where collections have been organized, valuable economic improvements have been achieved.

The regimentation of Nature's store of variability into collections for the ready use of the science of plant breeding needs to be interpreted in the last analysis as necessary organization for the benefit of humanity. Dr. G. D. H. Bell (Plant Breeding Institute, Cambridge) outlined the need for crop improvement in terms of the demands and responsibilities of the more advanced nations. World food production is now recognized as a world problem, and communities of people as they advance expend less and less of their energies on primary food production. Thus with vast new areas awaiting development on one hand, and shrinking acreages such as those of the British Isles demanding that maximum production be achieved at an economic level on the other, the plant breeder to-day is vital to survival. This sense of urgency has already been recognized both by sovereign countries and by international organizations such as the Food and Agriculture Organization and the Organization for European Economic Co-operation.

Notwithstanding such considerations, Dr. Bell emphasized that it is the need for the application of more scientific methods, and the great complexity

of the problems to be solved, that have made necessary the provision of adequate and intelligent facilities for plant breeding. No longer can we afford to rely on a division of science into the pure and the applied, and wait for a piece of research to be completed in its appropriate pigeon-hole before further progress is attempted. Nor can we expect a science without scientists, and the training of a plant breeder presents yet another of those educational problems which most university curricula have so far failed to solve. WATKIN WILLIAMS

UNIVERSITY OF OXFORD SCHOOL OF FORESTRY

ON October 1, the University of Oxford School of Forestry celebrated its golden jubilee in the Imperial Forestry Institute, which has been its home since 1950, and in St. John's College, which has been very closely associated with it throughout the fifty years of its existence. When the Royal Indian Engineering College at Coopers Hill (near Windsor) closed in 1905, training for the Indian Forest Service which had been given there since 1888 was transferred to Oxford, temporary accommodation having been secured to serve until the building promised by St. John's was ready. The director, Dr. (afterwards Sir William) Schlich, and his assistant W. R. Fisher brought over the current class of twelve probationers and thus opened the first university forestry school in Britain (or indeed the British Empire), though Edinburgh already had a lecturer in forestry. The senior of this group, A. E. Osmaston, officiated at the planting of a jubilee oak tree at the recent celebrations. This was done in Bagley Wood, which has been continuously available to the School through the generosity of St. John's, the owner of the wood for four centuries. Mr. Osmaston is one of a famous forestry family of which seven members are serving or have served in the Forest Services of India, Britain and the Colonies ; three were present on this occasion. He was assisted by one of the present students, and a gathering of about 130 persons, nearly all former students or members of the staff, witnessed the ceremony.

The jubilee address was delivered by Sir Harold Glover, one of the first students to read forestry in Oxford, his year being headed by the late Lord Robinson, sometime chairman of the Forestry Commission. Many of that year took degrees in natural sciences, as well as the Forestry Diploma. Sir Harold joined the Indian Forest Service, Oxford having been for some years the only training centre for Indian Service probationers ; between 1907 and 1932, when recruitment in the United Kingdom ceased, 213 out of the total intake of 306 had passed through the School. The last five inspectors-general in India have been Oxford graduates, including the present holder of that important post.

In 1924, the School was strengthened by the establishment of the Imperial Forestry Institute to provide a centre for higher education and research for those parts of the Empire which needed such facilities : though the Institute was in no sense a part of the School, many facilities such as the library were shared, and members of the Institute staff undertook some of the teaching. The two organizations were amalgamated in 1938 to form the University Department of Forestry. In the early years, only a diploma was awarded on the work of the two or three years the course covered, but a pass degree was granted in 1918, and finally an honours degree in 1944.

The School has provided 144 recruits to the Colonial Forest Service, and since the opening of the Institute, practically all members of that Service have attended postgraduate courses in Oxford. The proportion of the officers of the United Kingdom Forestry Commission trained at Oxford has been lower, but forty-four are serving at present, and the Commission's research staff worked at Oxford before the research station at Alice Holt was established.

A lunch was given in St. John's College, the speaker being Sir Henry Beresford-Peirse, deputy director-general of the Forestry Commission. He made particular reference to the very wide range of subjects covered in a university forestry course, giving it an educational value much beyond a technical training.

The average number of students over the past three years has been fifty-eight, and the number graduating twelve. There are at present students from the United Kingdom, Canada, New Zealand, South Africa, India, Pakistan, Burma, Ceylon and several Colonies. The staff now consists of the professor, one reader, sixteen demonstrators, twenty technical assistants, twelve secretarial and librarian employees and six others, and the annual expenditure approximates £50,000. H. G. CHAMPION

OBITUARIES

Prof. H. K. Mookerjee

THE death occurred very suddenly on August 18 of Prof. H. K. Mookerjee, professor and head of the Department of Zoology of the University of Calcutta. Born in 1898, Mookerjee's undergraduate days were spent in the Presidency College, Calcutta. He won the University Gold Medal in zoology in 1924, and joined the University as assistant lecturer in 1925. As the Guruprasanna Ghose Scholar, Mookerjee went to London in 1926, and worked in the Imperial College of Science and Technology under the late Prof. E. W. MacBride. His work on the development of the vertebral column attracted considerable attention. He was Sara Marshal Scholar in the Imperial College during 1927–28, and Ghose Travelling Fellow of the University of Calcutta during 1928–29. He was awarded the D.Sc. of the University of London in 1930. He rejoined the University of Calcutta on his return, and in 1933 became the University professor of zoology, which post he filled with great credit until the end of his life.

Prof. H. K. Mookerjee's important contribution in the field of embryology and evolution was based on the study of development of the axial skeleton of practically all groups of the chordates starting from *Balanoglossus* right up to man. He pointed out further that the centrum of all the chordates is formed in the same manner according to a basic plan ; in the development of the vertebral centrum of all the chordates, from *Amphioxus* up to the mammals, only notochord, chord sheath, and the pericordal tube formed around the latter, take part, according to Mookerjee, but not the arch-bases or other elements claimed previously. Besides this hypothesis, Mookerjee also pointed out the many characteristic changes that take place in a non-plastic organ like the vertebral column along with change

of environment. Very recently, he had shown that the so-called notochord of *Balanoglossus* is really the true dorsal nerve cord with a definite neurocœl. He utilized this finding to draw up the affinity of the *Balanoglossus* in a recent paper.

Prof. Mookerjee was elected president of the Zoology Section of the Indian Science Congress in 1936 and was elected a Fellow of the National Institute of Sciences of India in 1939. He was associated with various learned bodies and connected with different Indian universities in various capacities. He acted as a secretary of the Asiatic Society in the Natural History Section and was the founder-president of the Zoological Society of Bengal. He was an important member of the senate and syndicate of the University of Calcutta.

Prof. Mookerjee was responsible for initiating fishery research in the University, and himself made notable contributions to the life-history of freshwater fishes of Bengal. He was admired and respected by all who came in contact with him. He leaves his mother, wife and one son and three daughters and a host of friends and admirers who mourn his loss.

S. R. Bose

Mr. Howard Evans

The death occurred, suddenly, on September 11, of Mr. Howard Evans, superintendent of the Laboratory of the Development and Research Department of the Mond Nickel Co., Ltd.

Mr. Evans was born in 1907. He was educated at the Grammar School, Penistone, after which he was for five years junior chemist at the Penistone Iron and Steel Works of Cammell Laird and Co., Ltd. During this period he was a student at the University of Sheffield, and graduated A.Met. with the award of the Mappin Medal and Premium in 1930. From 1930 until 1938 he was employed as research metallurgist in the Physics Section of the Research Department of the Metropolitan-Vickers Electrical Co., Ltd., Manchester, except for one year, when he was working on iron–aluminium alloys on a George Senior fellowship at the University of Sheffield. It was during this period that he co-operated with Dr. C. Sykes in his classic work on order/disorder transformations.

In 1938, Mr. Evans joined the Development and Research Department of the Mond Nickel Co., Ltd., as a research metallurgist in the Birmingham Laboratory, under Dr. L. B. Pfeil. After a period of activity on various research projects relating to steel, including work on steel castings and on temper brittleness, he became closely associated with war-time investigations undertaken by that company on behalf of government departments. To all this work he brought outstanding energy and enthusiasm, a meticulous attention to detail and insistence on an excellence of performance from which he would never depart.

In 1945 he was appointed principal assistant to the superintendent, and in May 1954 superintendent of the Laboratory. In these capacities he was connected with a wide variety of research projects in both the ferrous and non-ferrous fields, and his indefatigable zeal was a constant inspiration to those with whom he worked.

Mr. Evans was elected a Fellow of the Institution of Metallurgists in 1946 and was a member of many metallurgical organizations, to which he presented numerous technical papers. During the year 1954–55 he was president of the Birmingham Metallurgical Society.

A notable feature of Mr. Evans's activities was his sincere interest in the training and education of junior members of his staff, many of whom have profited by his sympathetic guidance and encouragement when embarking upon a metallurgical career. His interest in technical education led him to undertake part-time lecturing for some years at the Birmingham College of Technology, despite his very heavy duties in other fields. He joined with typical wholeheartedness and no little skill in the recreational life of his colleagues and continued to take part in many of their sporting activities right up to the time of his death.

In all the many circles in which he moved, Howard Evans will long be remembered for his enthusiasm, initiative and ability to get things done.

W. Steven

NEWS and VIEWS

Editor of *Science* and *The Scientific Monthly*: Prof. G. DuShane

Prof. Graham DuShane, of Stanford University, has been appointed editor of *Science* and *The Scientific Monthly*, the two journals published by the American Association for the Advancement of Science. Prof. DuShane, who is forty-five years old, took his Ph.D. degree at Yale in 1934 for embryological work and then did two years of research in the University of Iowa and in Stanford University. The following ten years were spent in the University of Chicago, teaching in the Department of Zoology and carrying out research on problems of amphibian morphogenesis. In 1946 he moved to Stanford University where, in addition to his work in embryology, he devoted himself to the development of the University's programme in general biology and gave freely of his services for editorial consultation and faculty committee activities and as the president of the Stanford chapter of the American Association of University Professors. Prof. DuShane goes to the editorship of *Science* and *The Scientific Monthly* initially on the basis of a year's leave of absence from Stanford. The breadth of his scientific knowledge, his facility in writing and editing, and his interest in the accurate communication of the findings and conditions of science are good auguries for the future of the Association's journals.

United Kingdom Agricultural and Food Representative in the United States: Mr. O. G. Williams

Mr. Owen G. Williams, provincial grassland officer for the East Midland Province of the National Agricultural Advisory Service, has been appointed to the new post of United Kingdom assistant agricultural and food attaché in Washington, D.C. The post of agricultural adviser (technical) has been discontinued, but its main functions will be incorporated in the new assistant attaché post. Mr. N. F. McCann, the former agricultural adviser (technical), will take up a new appointment as deputy director of the

National Agricultural Advisory Service in the Yorkshire and Lancashire Province. Mr. Williams, who is forty-three, graduated in agricultural botany from the University College of North Wales, Bangor, in 1941. Before his university studies he had considerable practical experience, including eight years on his father's mixed farm in the Conway Valley and a year as manager of a large dairy farm. He joined the Ministry of Agriculture and Fisheries in 1942, becoming two years later a technical development officer for the county of Buckinghamshire. Mr. Williams has taken particular interest in the development of herbage seed growing in Buckinghamshire and the East Midlands, and has been a member of the Management Committee and vice-chairman of the Certifying Committee of the Lincolnshire Seed Growers' Association. He has also been a member of various young farmers' clubs advisory committees and has lectured frequently to farmers' clubs and societies. He was one of the official United Kingdom delegates to both the Fifth International Grassland Congress held in Holland in 1949 and the Sixth Congress held in the United States in 1952, and at the latter he afterwards toured extensively in the Middle West, visiting farms and research stations.

Royal Aeronautical Society: Mr. E. T. Jones, C.B., O.B.E.

Mr. E. T. Jones, principal director of scientific research (air), Ministry of Supply, has been elected president of the Royal Aeronautical Society for the year 1956–57 and will take office at the annual general meeting of the society, to be held on May 10, 1956. Mr. Jones, who is fifty-eight, was a pilot and flying instructor in the R.F.C./R.A.F. during 1915–19, and then graduated from the University of Liverpool. During 1923–30 he was with the Aerodynamics Department, Royal Aircraft Establishment, and for eight years was with the Marine Aircraft Experimental Establishment, Felixstowe. During the Second World War he was chief superintendent of the Aeroplane and Armament Experimental Establishment, Boscombe Down; in 1947 he was appointed director of instrument research and development at the Ministry of Supply, and was promoted to his present position at the Ministry in 1949. Mr. Jones was created an O.B.E. in 1942 and C.B. in 1953.

American Academy of Arts and Sciences: Award of Francis Amory Prizes

Francis Amory prizes of 3,500 dollars each, for the invention or discovery of measures for the relief or cure of diseases affecting the genito-urinary system, have been awarded by the American Academy of Arts and Sciences as follows: Frederic E. B. Foley, Lowry Medical Arts Building, St. Paul, Minnesota, for outstanding inventive and surgical genius in the treatment of those afflicted with urological disease; Choh Hao Li, University of California, Berkeley, California, for his work on the relation of the anterior pituitary hormones to the maintenance and functioning of the human reproductive organs; T. R. R. Mann, Molteno Institute, University of Cambridge, for his basic contributions to the biochemistry of reproductive functions providing basic data stimulating research and clinical progress; Terence J. Millin, Queen's Gate Clinic, London, for his contribution to surgery; Warren O. Nelson, College of Medicine, State University of Iowa, for his studies of the structural relationships of the male sex organs and of the factors that determine the functional activities of their components; Frederick J. Wallace, American Cystoscope Makers, Inc., New York, for his co-operation with the urological profession in developing diagnostic and therapeutic instruments which have contributed materially to the technical advances in this specialty; Lawson Wilkins, Johns Hopkins University, Baltimore, Maryland, in recognition of his contributions to fundamental knowledge of the growth and development of secondary sex characteristics in man and his application of the adrenal cortical hormone to their management and treatment.

New Headquarters for the Institute of Biology

The Institute of Biology, having spent the first five years of its existence in rooms at Tavistock House, has moved to new premises at 41 Queen's Gate, London, S.W.7 (Tel.: Western 2229). The new rooms are in the house of the Royal Entomological Society, and the meeting room of this Society is to be made available to the Institute of Biology for certain of its meetings. The removal marks a stage in the development of the Institute, which has now achieved a membership of twelve hundred full members, seventy probationer members and three hundred student members. The new headquarters will provide facilities not previously available to members. In particular, a members' room has been provided in which members will be able to meet friends, conduct interviews and hold small discussion groups. A telephone and ample space for writing and reading will be provided. A selection of works of reference will be available, and there will be a frequently changed display of recent books on biological subjects, maintained by a leading scientific bookseller. While it is not proposed to attempt to build up a comprehensive library because of the existence of the neighbouring libraries dealing with various branches of biology, the Institute may establish a collection of books on the broader aspects of biology which will include copies of the classic works of the past. It is hoped that the new rooms will be found useful, possibly in different ways, by members from the Colonies spending long leaves in Britain, by the many members in the London area who have no access to similar facilities in central London and by those from other parts of Britain paying brief visits to London.

Television Transmitter at Meldrum, Aberdeenshire

The opening on October 12 of a new B.B.C. medium-power transmitting station at Meldrum, Aberdeenshire, brings television within the reach of about half a million people living in the north-east corner of Scotland, south of the Moray Firth. This transmitter replaces the temporary low-power transmitter at Redmoss, Aberdeen, the useful service-area of which did not extend much beyond the city boundaries. The 5-kW. vision and 1·25-kW. sound transmitters, manufactured by Marconi's Wireless Telegraph Co., Ltd., feed a three-stack 'batwing' aerial mounted at the top of a 500-ft. steel mast. The mast and station are situated on a hilltop, so that the aerial is about 1,300 ft. above sea-level. About halfway up the mast is an eight-tier slotted aerial from which the B.B.C. Home, Light and Third programmes will be radiated when frequency-modulated very-high-frequency transmitters are installed early in

1956. No studios are provided at the station. The video signal from the Kirk O' Shotts transmitter is picked up at a Post Office receiving station at Cupar and relayed to Old Meldrum via a two-stage microwave link. Additional microwave aerials and receivers are available for use with outside broadcast units. The audio signal comes over Post Office landlines with some inevitable loss of the higher audio frequencies. A low-power (500 W. vision, 125 W. sound) transmitter, manufactured by Standard Telephones and Cables, Ltd., is installed for use should the main transmitter fail. It is supplied from a diesel alternator. The main transmitter can draw its power from either of two independent 11-kV. ring mains operated by the North of Scotland Hydro-Electric Board, and the customary stand-by diesel alternator has been dispensed with.

Patent Office Library Centenary

The Patent Office Library, at 25 Southampton Buildings, Chancery Lane, London, W.C.2, has just celebrated its centenary year with an exhibition of literature illustrating the development of the industrial arts through the century of its existence. The exhibition showed industrial development by decades and included specifications of basic inventions, manufacturers' catalogues and scientific and technical periodicals which appeared in each period of the century covered. The material displayed was an attempt to demonstrate the resources of the Library and to illustrate the importance of patented inventions in the foundation of great industries. Some original examples of manufactured products, now widely known and used, were displayed as a focus to the exhibition of literature. A special tribute was paid in the exhibition to Bennet Woodcroft, F.R.S., the first clerk to the Commissioners of Patents and founder of the Library.

Documentation of Spectra by Punched Cards

The documentation of new scientific data so that it remains within readable bounds presents a growing problem, and the difficulties are especially acute in those fields of pure and applied research where the solution of a particular problem demands a preliminary exhaustive search in the literature for physico-chemical reference data. For example, there is a recognized urgent need for spectral data in a compact form. This applies especially to infra-red and Raman data for use in physical or organic chemistry and for analysis, all the more since lack of space and costs now prevent full publication of such material in the scientific journals. A joint Anglo-German scheme for the documentation of molecular spectra, recently announced by Butterworths Scientific Publications (88 Kingsway, London, W.C.2) and Verlag Chemie (Weinheim/Bergstrasse), is therefore welcome news for many academic and industrial laboratories. The spectra of pure compounds, and of other technological products, will be provided on punched cards, with much other structural and spectral information. A detailed code which applies to the punched holes has been designed so that the cards can be used to provide the answers to a wide variety of questions which often occur in research. The spectral cards are also linked to a current literature survey, which adds to their intrinsic value. Details of the scheme, which is expected to begin in 1956 with about two thousand cards annually, can be obtained from the publishers.

Hair Embroidery in Siberia and North America

No. 7 in the series of Occasional Papers on Technology of the Pitt Rivers Museum, Oxford, deals with the subject of "Hair Embroidery in Siberia and North America" (pp. 83+16 plates; from the Museum, 1955; 15*s*.). Mr. Geoffrey Turner, who has been closely associated with the Museum for many years, has made a deep study of the North American Indians and their material culture, and no one in Great Britain is better at placing a given specimen. Moose and reindeer hair embroidery are often confused with porcupine quill work, and Mr. Turner shows how they may be distinguished, also explaining how the various techniques are carried out and where they are found. In addition, he outlines what is known of the historical background, showing the effect of French influence on the development of the craft in North America. The paper will be indispensable to all museum curators who have North American or similar Asiatic material under their care, and it is to be hoped that more of Mr. Turner's learning will be published in future numbers of the series.

Illuminating Engineering Society

At the first meeting of the Illuminating Engineering Society for the 1955–56 session, Mr. A. G. Higgins, assistant secretary of the Institution of Gas Engineers, took office as president. Mr. Higgins formerly held a number of positions with the South Metropolitan Gas Co., including that of outdoor lighting superintendent.

The following awards have been made for papers presented to the Society during the past year: *Leon Gaster Memorial Premium*, to Dr. W. E. Harper (Plastics Division, Imperial Chemical Industries, Ltd.) and Mr. A. G. Palmer (North Thames Gas Board) for their paper entitled "Lighting of Hazardous and Corrosive Locations in Industrial Plants"; *Silver Jubilee Commemoration Award*, to Mr. K. R. Ackerman (British Broadcasting Corporation) for his contributions to lighting design and brightness patterns.

Royal Institution: Lectures

The programme of lectures at the Royal Institution up to Christmas includes seven Friday Evening Discourses, beginning October 28, as follows: Sir Edward Salisbury (director of the Royal Botanic Gardens, Kew), fruit and seed production; Sir Graham Sutton (director of the Meteorological Office), weather forecasting—the future outlook; Dorothy L. Sayers (author), 'Œdipus Simplex'—freedom and fate in folklore and fiction; Dr. C. F. A. Pantin (reader in zoology, University of Cambridge), the primitive nervous system; Dr. B. F. J. Schonland (deputy director of the Atomic Energy Research Establishment, Harwell), lightning and the long electric spark; E. J. H. Corner (lecturer in botany, University of Cambridge), botanical collecting with monkeys; and Sir Lawrence Bragg (resident professor and director of the Laboratories at the Royal Institution), the discovery of useful electricity. In addition to the Discourses, Prof. J. B. S. Haldane (Weldon professor of biometry, University College, London) will deliver the Woodhull Lecture on October 27 at 6 p.m., speaking on "The Prospects for Eugenics". R. H. Macmillan (lecturerer in engineering, University of Cambridge) will give four lectures on Tuesdays (at 6 p.m.) beginning October 25, on the subject of automatic control and production. On November 3, 10 and 17 (at 6 p.m.), Dr. R. C. Sutcliffe (deputy director of the Meteorological

Office) will give three lectures on large-scale weather processes. Both these sets of afternoon lectures are open to the public (2*s.* 6*d.* per lecture). The Christmas Lectures will be given by Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham, who will speak on "Big Molecules". Lectures, illustrated by experiments, have also been arranged for school children, and refresher courses for science teachers will be given. Details of these have been sent to education authorities in the London area and it is hoped that this new venture in science teaching, which Sir Lawrence Bragg started so successfully last year, will become an important part of the Royal Institution's work.

Iron and Steel Institute

THE eighth Hatfield Memorial Lecture of the Iron and Steel Institute will be given on October 7, at 6.30 p.m., in the Firth Hall of the University of Sheffield by Dr. E. C. Bain, vice-president, research and technology, of the United States Steel Corporation, his subject being "Trends in Metallurgical Research in the United States". Admission will be by ticket only, obtainable from the Registrar, University, Sheffield 10. A half-day meeting of the Iron and Steel Engineers Group will be held at the Engineers' Club, Manchester, on the morning of October 20, in connexion with the National Fuel Efficiency Exhibition; Dr. W. S. Walker (Round Oak Steel Works, Ltd.) will present a paper on "Fuel Efficiency in the Iron and Steel Industry". The autumn general meeting of the Institute will be held during November 16–17, at the offices of the Institute, 4 Grosvenor Gardens, London, S.W.1.

Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A NUMBER of Commonwealth Fund fellowships are again being offered by the Commonwealth Fund of New York to British subjects, for study and travel in the United States. All expenses of travel, study and living will be met, with some adjustment of stipends for married men. The fellowships, which are open to British men and women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *General:* twenty fellowships to graduates of a university in Great Britain or Northern Ireland; candidates must be available in London for interview in March 1956; age, 23–32; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, preferably less than 40; tenure, 9–15 months; applications by December 10. *Australian and New Zealand Civil Services:* five fellowships to Civil servants in the Governments of Australia and New Zealand; age, less than 40; tenure, 9–15 months; applications by November 1. *Oversea Civil Service:* two fellowships to Civil servants in the Governments of British Colonies, Protectorates and Trust Territories; age, less than 40; tenure, 9–15 months; applications by November 18. *Journalism:* three fellowships to journalists practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies:* four fellowships to faculty members appointed to or holding posts in American studies in universities in the United Kingdom; candidates to be nominated by their universities; tenure, 4–15 months (these fellowships are not limited by previous study in the United States). Application forms and further information can be obtained through British universities or Government departments, or from the Warden, Harkness House, 35 Portman Square, London, W.1.

Announcements

PROF. R. C. GARRY, regius professor of physiology in the University of Glasgow, and Mr. H. J. Seddon, director of studies in the Institute of Orthopædics, University of London, and clinical director of the Royal National Orthopædic Hospital, London, have been appointed members of the Medical Research Council.

ON the occasion of a visit to Great Britain by Prof. J. Heyrovský, of Prague, an advanced course on polarography will be given at the Royal Technical College, Salford, Lancs, during November 18–19. A number of lectures will be given, including two by Prof. Heyrovský; and there will be a demonstration of apparatus. The fee for the course is one guinea. Further information can be obtained from the Head of the Department of Chemistry and Applied Chemistry at the College.

MR. W. H. RUTHERFORD has been appointed assistant secretary of the Royal Society of Edinburgh in succession to Mr. G. A. Stewart (see *Nature*, October 8, p. 675). Mr. Rutherford, who has been on the staff of the Society since 1940, has served as Mr. Stewart's deputy since 1948. Educated at the High School of Dundee, he was elected a fellow of the Society of Secretaries in 1951, an associate of the Corporation of Secretaries in 1954, and is a member of the Royal Institute of Public Administration.

PROF. F. J. LLEWELLYN, professor of chemistry in Auckland University College, New Zealand, and formerly senior lecturer in chemistry at Birkbeck College, London, and I.C.I. Research Fellow in the University of Birmingham, has been appointed rector of Canterbury University College, Christchurch, in the University of New Zealand.

DR. F. H. K. GREEN has resigned from the secretaryship of the (European) Scientific Advisory Committee of the Lady Tata Memorial Trust, which he has held since 1934, on his appointment as scientific secretary of the Wellcome Trust. He will be succeeded by Dr. David Galton, of the Chester Beatty Research Institute, Fulham Road, London, S.W.3.

AT the October meeting of the Board of the Institute of Physics, it was unanimously resolved to record in the minutes that it had noted that the British physicists, under the leadership of the president (Sir John Cockcroft), played a prominent part in the recent United Nations Conference on "The Peaceful Uses of Atomic Energy", and was happy to see this further contribution to one of the Institute's principal objects, namely, the advancement and diffusion of a knowledge of physics, pure and applied.

REFERENCE was made in *Nature* of August 13, p. 297, to a paper on the drying of skins, published in *Colonial Plant and Animal Products*. The authors of this paper were Dr. M. H. French and Dr. R. L. Sykes; we regret that Dr. French's name was omitted.

CINEMATOGRAPHY IN SCIENTIFIC RESEARCH

PROGRESS in scientific research depends on precision instruments, because accurate quantitative data alone can form the ultimate basis of new discoveries. Although infinitely versatile, our human sense organs are very limited when accurate measurements are needed, be they of size, or length or of weight. The invention of the microscope, the micrometer and of the chemical balance have each opened large fields of research, and their accurate measurements have greatly advanced biology, engineering and chemistry. Without such instruments, and the ciné camera is one of them, scientific research would scarcely have progressed beyond the speculative and descriptive stage. To demonstrate the latest results achieved by scientific cinematography, the Scientific and Technical Group of the Royal Photographic Society arranged a special morning session on September 3 at the British Association meeting in Bristol. In spite of many other attractions, it was extremely well attended, and the audience numbered more than three hundred.

The meeting was opened by R. J. Hercock, chairman of the Scientific and Technical Group, who introduced the programme, and by Prof. N. F. Mott, who took the chair during the morning. Prof. Mott was of the opinion that research films are well suited to bring together scientific workers from many different disciplines, and that this is one of the main functions of the British Association. He was followed by Dr. A. R. Michaelis, who had been responsible for the organization of this session. Dr. Michaelis gave a brief outline of the history of the subject, of E. J. Marey's classical contribution and his insistence on the quantitative nature of all scientific cinematography, which he hoped would be stressed by all the other speakers. He mentioned the many cinematographic techniques which have been used in scientific research and gave a few classical examples of their applications in different fields.

The use of high-speed cinematography in physical and engineering research was the subject of W. D. Chesterman's (Royal Naval Scientific Service) paper and research film. A wide range of problems was shown on the screen, particularly noteworthy being underwater sequences of cavitation phenomena, partly recorded on models in hydrodynamic flow channels and partly recorded in the open sea. Spark cinematography at frequencies up to 100,000 frames/sec. was demonstrated in ballistic research work and showed in detail the impact of projectiles on armour plating. Mr. Chesterman concluded with a plea for the wider use of underwater cinematography by marine biologists, who might well use this established technique for the study and recording of their subjects in natural surroundings.

An example of the use of high-speed cinematography in industrial research was presented by D. J. Dearnley (Central Research Establishment I, National Coal Board). Froth flotation of fine-coal particles was cinematographically recorded at 2,500 frames/sec. in order to elucidate the mechanism and efficiency of grain attachment to air bubbles. A field-splitting optical system was developed in order to record each bubble simultaneously from two directions at right angles, and from the resulting research film, received with applause at the meeting, it proved possible to measure collection efficiency and contact times as well as to plot the trajectories of particles and bubbles.

The most outstanding research film shown at the meeting was the one dealing with the behaviour of living cells in tissue culture, presented by E. J. Ambrose (Chester Beatty Research Institute, London) and recorded in collaboration with M. Abercrombie (University College, London). Combining the new technique of Smith (Baker) interference microscopy with time-lapse cinemicrography, Dr. Ambrose was able to show a colour film which left a deep impression on all who saw it and which was received with much applause. The advantage of this new technique was the demonstration of changes in thickness of cells, shown by marked colour changes, and thus providing an extra dimension in the depth of the recorded image. In the film, the behaviour of normal and cancer cells was contrasted, showing that, when two normal cells make contact, adhesions occur on their surfaces which do not take place in the case of tumour cells. Particularly outstanding was the record of the behaviour of cancer cells in the presence of ribonuclease; this enzyme stimulated the free movements of the cancer cells even further and led to their death through over-digestion of the enzyme.

High-speed cinematography through the microscope, a rare and extremely difficult research technique, was demonstrated with three examples by R. McV. Weston (Simpl, Ltd.). After explaining the technical problems of the technique, Mr. Weston showed its use for recording the movement of mercury in a clinical thermometer, for examining the lever escapement of a watch and for the discharge of elaters and spores from a liverwort. The first two films showed hitherto unknown defects, and the third allowed quantitative evaluation by Prof. C. T. Ingold (Birkbeck College, London), for whom it was taken. In the absence of Dr. J. S. Courtney-Pratt in the United States, Mr. D. P. C. Thackeray (Research Laboratory on the Physics and Chemistry of Surfaces, Cambridge) presented a brief paper and a research film made by the Courtney-Pratt image-sampling technique; the subject of the film was the explosion of single crystals.

X-ray cinematography, both of the direct and the indirect method, was shown by G. E. H. Foxon (Biology Department, Guy's Hospital Medical School, London); the ingenious use of 'Meccano' gears was greatly admired in a film more devoted perhaps to an exposition of technique than of results. J. Underwood (G.K.N. Group Research Laboratory) gave the last paper, describing further examples of the use of high-speed cinematography in industrial research: his first high-speed film showed the passage of liquid in a heat-exchanger model; his second the initiation of a welding arc under an argon shield by a condenser discharge; and his third, taken at 5,000 frames/sec., allowed the determination of the acceleration characteristics of the blades of a flying shear. Altogether, thirteen films were shown at the meeting, which concluded with excerpts from the American research film, "Color Motion Pictures of the Whole Sky".

Four German research films which had been specially sent over for this meeting were projected

two days later during the general festival of scientific films. Two of these were "Netzbau der Kreuzspinne" and "Pervitinwirkung bei der Kreuzspinne"; both were made by Prof. H. M. Peters (Zoological Institute, University of Tübingen). The second of these two was particularly noteworthy, as it allowed the quantitative evaluation of the action of benzidrine on the spider *Aranea diadema*; this was achieved by plotting against time the intervals along the radial threads of the web. "Biologie des Hamsters", Parts 1 and 2, were produced by Dr. I. Eibl-Eibesfeldt (Department of Animal Behaviour, Max-Planck Institute for Marine Biology, Buldern, Westphalia) and showed some remarkable instances of mating behaviour of hamsters as well as of their young. These four films were lent by the Institut für den wissenschaftlichen Film, Göttingen, through the courtesy of its director, Dr. G. Wolf.

There can be no doubt that this first collective presentation of research films from many disciplines at a meeting of the British Association was a great success, as the frequent and often lengthy applause by the audience amply demonstrated. The hope can only be reiterated in this article that, at the meeting next year in Sheffield of the British Association, all those who have made research films in the meantime will use the opportunity to present their results; the films should be submitted to either the Scientific and Technical Group of the Royal Photographic Society or to the Scientific Film Committee of the British Association.

A. R. MICHAELIS

RADIOCARBON DATING

CONFERENCE IN CAMBRIDGE

THE second conference on radiocarbon dating held in Europe took place in Cambridge during the week July 25–30. Dr. H. Godwin, head of the Cambridge dating laboratory at the University Subdepartment of Quaternary Research, Botany School, was the host and inspiring organizer of a most successful and instructive symposium. He assembled a small group of scientists representing almost all the dating stations in Europe, plus a few physicists who are in the process of setting up dating equipment. Thanks to a generous grant from the Wenner-Gren Foundation, New York, it had also been possible to invite a few of the leading Americans in this field. Thus, the conference was a first step towards the goal set in Copenhagen a year ago, where the establishment of closer personal contact with American colleagues was considered essential for future discussions—in Europe—of the implications of radiocarbon dating.

The Cambridge conference was devoted almost exclusively to the discussion of new methods, which have undergone rapid development in the past two years. The classical Libby method of 'counting' solid carbon in the screen-wall counter is being abandoned, mainly because the widespread contamination of the atmosphere with radioactive dust —although probably too low to be of significance as a health hazard—represents a serious menace to accurate low-level assay. This is particularly true in the case of 'black carbon' samples with their extremely large surfaces and high adsorption capacities.

In the United States and in Europe, a number of new approaches to the measurement of natural radiocarbon have been made simultaneously; for example, gas counting of carbon dioxide, acetylene and methane, and scintillation counting in which the sample to be dated is incorporated into the scintillator. Each of the methods mentioned was discussed in detail at the Cambridge conference, and a comparison of the merits of various techniques was attempted, especially as regards the ease and speed of operation, the accuracy achieved within a given counting time, the relative sample sizes, etc.

Just as at last year's conference in Copenhagen, the question of errors of radiocarbon ages was the subject of lively discussions. In the solid carbon method, the statistical error of the net count represents the largest contribution to the error of the final result. As this error is being suppressed by improving the ratio S^2/B (sample over background), other factors such as isotopic fractionation during processing of the samples, variations in the natural isotopic constitution of the unknown and the reference sample, and the uncertainty in the half-life of radiocarbon, etc., begin to play an appreciable part in estimating the accuracy of radiocarbon measurements. Different errors have been combined in a variety of ways, and very few publications contain a concise statement as to how the errors listed have been computed.

A solution of this problem acceptable to all participants could not be found during the Cambridge meeting; but it was agreed that the manner in which the error is calculated should be stated explicitly in future publications.

Moreover, the standardization of the form of publication of dating results was discussed. All investigators present agreed that dating results should be collected at regular intervals for publication in either *Nature* or *Science*. They should preferably appear in the form of date lists similar to those issued by Libby, containing only a brief description of the sample, its current laboratory number and the station's identification prefix letter (cf. below). Obviously, publication of date lists will not replace presentation of the same results in their proper context in any other scientific journal; however, it will make the dating results of various stations more readily accessible to those interested in any one of the widely differing fields of application of the radiocarbon dating method. Also, the results of inter-laboratory cross-checking and standardization, as well as of mass-spectrometric monitoring, are of interest to many workers in this and related fields, and all data should be made available to the widest possible circle of readers. A list of the dating stations in operation or close to completion, and the identification prefix letters used or accepted for use by these stations, is given in Table 1, and additional information will be appreciated.

Table 1. DATING LABORATORIES

BM	British Museum, London	*P*	Philadelphia
C	Chicago	*Q*	Cambridge, England
GRO	Groningen	*R*	Rome
G	Gothenburg	*GL*	Royal Institution, London
H	Heidelberg	*S*	Stockholm
K	Copenhagen	*T*	Trondheim
L	Lamont (N.Y.)	*W*	Washington
M ?	Michigan	*Y*	Yale
?	Manitoba	?	New Zealand
		?	Poznan, Poland

In this connexion it may be mentioned that an informal exchange of scientific information between European dating laboratories has been in existence for almost two years, and an effort is being made to maintain and widen such contacts among scientists actually engaged in radiocarbon dating.

The meeting in Cambridge has given ample evidence of the great need for and interest in small conferences, where experience and progress within this rapidly developing field are discussed informally. The method of radiocarbon dating is still new, and further technical improvements are likely to come. On the other hand, its wide range of applicability has not yet been fully understood and appreciated. Therefore, joint meetings of physicists and chemists with archæologists, geologists and other users of dating results are bound to be mutually instructive and stimulating, provided the groups can be kept small and scientists with as remotely related interests as atomic physics and history of human cultures can discuss the essentials, each making an effort to understand the others' problems. Hilde Levi

ANIMAL PRODUCTION FROM GRASS

THE theme of "Animal Production from Grass" proved a most successful choice for the fifth 'study meeting' of the European Association of Animal Production, which was held at Reading during July. Representatives of seventeen countries were present, and all stayed in two of the University's halls of residence; this contributed on the social side towards the success of the meeting.

As a preliminary to the meeting, most of the visiting European delegates took part in a tour beginning with a visit to the Royal Show at Nottingham, where the Council of the Royal Agricultural Society extended its hospitality to the visitors. Particular interest was shown in the display of British breeds of livestock. Afterwards, visits were made to the research farm at Thurgarton and the Veterinary Research Unit of Messrs. Boots, and to Mr. Maurice Passmore's farm at Wormleighton.

At Reading, the theme for discussion was introduced by two main papers, each being followed by shorter reports on current research in the various countries. On the first day, Prof. M. M. Cooper, of King's College, Newcastle upon Tyne, delivered the chief contribution on "Animal Management for Intensive Production from Grass". This comprehensive review of the present position in farm practice and in the experimental field was both stimulating and provocative and delivered with characteristic vigour. Prof. Cooper directed attention to the discrepancies that exist between the recorded output from grassland under experimental conditions and that obtained on most farms, even those under more progressive management. For this the farmer must not be judged harshly. Many lack the capital to ensure better utilization, while generally there is a lack of the technical knowledge of how to produce grass with "the composition of a watered concentrate for eight or nine months of the year in sufficient quantities to meet the nutritive demands of high-producing cows"; and there is no simple recipe the adviser can give the farmer to enable him to do so.

In Britain the well-distributed rainfall and the fact that eighty acres is the size of the typical farm have made the higher efficiency of the dairy cow a dominating factor, and she is the pivot of a system of mixed farming. The meat-producing sheep is important on large arable farms and on the large, preponderantly grass farms of the north, where cattle may be merely mowing machines to keep the grass in good condition for maximum mutton production. One of the current problems is the extent to which sheep can be integrated into dairy farming. Some sheep on a typical large dairy farm are a necessity for proper pasture management; and in establishing a directly re-seeded pasture, they are invaluable in effecting consolidation and controlling weeds in the early stages. Used sensibly, they can augment the quality of grazing for the dairy herd; but in such circumstances, they are essentially scavengers, which is also their proper role on a large arable farm with limited grass.

Prof. Cooper also discussed systems of grazing, pointing out that trials in New Zealand gave better live-weight gains, carcass weights and lamb grading from rotational grazing where the stocking-rates were high than from non-rotational grazing, but that at low rates of stocking the reverse was true. On conservation of grass we have much to learn from Continental countries. Though we should aim at maximum use *in situ*, with the reduced conservation losses, lower handling costs and better return of animal excrement to maintain fertility, conservation is also essential and is a means as well as an end in intensive pasture management.

Finally, Prof. Cooper appealed for a better assessment of nutrient off-take from pasture. It is absurd to credit full value to concentrates and other foods of known analysis, leaving grass and grass products to carry all the errors of estimate. Such a system, now current, discounts the value of grassland under a system where both grass and concentrates are fed, and makes intensive grassland management appear less efficient than it actually is.

The first of the subsidiary papers was by Dr. W. Holmes and D. S. MacLusky, of the Hannah Dairy Research Institute. They reviewed the effects of pasture management methods on the production and feed consumption of dairy cows in trials on the Institute's farm. Production per acre was in many cases the final objective, and for this purpose maximum herbage consumption per cow might not be the best policy, as it might be obtained at the expense of efficient food conversion. Possibly slightly more mature herbage than the ideal may sustain more cattle per acre with only negligible reduction in yields per cow. Provided weather and good management ensure a constant supply of good grass, the strip-grazing method without cutting the grass or providing supplementary feed appear to give the most satisfactory results.

In a report of "A Comparison of Systems of Sheep Grazing Management" carried out at Wye College, Kent, H. Cornforth dealt with two sheep-grazing trials. Where nitrogenous fertilizers were used, rotational grazing gave the best utilization. Three days appeared to be the maximum that fattening sheep should remain on each plot. Gang-mowing had an advantage under continuous grazing where no nitrogenous fertilizer was used, but not where nitrogen was applied. Rotational grazing of a sward treated with nitrogen gave almost 700 lb. live-weight gain per acre, which is 27 per cent better than from a continuous grazing treatment on the same light chalk soil.

Other papers in this section were from Yugoslavia, Germany, The Netherlands, Austria, Portugal and Switzerland. That from P. B. De Boer, a Netherlands farmer, outlined his methods of intensive grassland farming, designed to try to eliminate the estimated

33 per cent loss of grown herbage in the process of grazing and conservation. This is done by strip grazing for limited periods and housing the cows at night. Each field is cut or grazed five or six times per season, nitrogenous fertilizer being applied following each cut or grazing period. By alternating cutting and grazing, palatability is improved. Dung is only applied to fields the crops of which are to be cut for silage the following season. The yield of cows shows that grass grown in September or October is not so productive of milk as that grown earlier in the summer. Starchy foods are used to balance the grass and give better utilization.

The second session of the meeting was devoted to the "Agronomic and Physiological Considerations governing Grassland Utilization". For this subject the principal paper was in two parts, the first on the physiological aspects being given by A. M. Frens, of The Netherlands State Agricultural Experiment Station at Hoorn, while the second, on the economic principles of grassland farming, was given by H. Dijkstra, of The Netherlands Agricultural Economics Research Institute.

Mr. Frens, in a clear and persuasive paper, pointed out the difficulties with which cattle on intensively managed pasture have to contend in dealing with the physical structure and high moisture content of young tender grass on which they are expected to live for long periods. Where the feed is low in fibrous and stemmy components, it tends to pack too closely in the rumen, and optimal microbial activity does not develop. This may lead in extreme cases to a deficiency of those nutrients of microbial origin which are essential to the animal's well-being. Not only so, but also the large quantities of water that have to be dealt with by animals living on luscious young grass strain their resorptive capacity, and water resorption from the intestines may be less effective than it physiologically should be. This results in soft fæces, in which an excess of minerals is excreted. Cattle which are scouring, moreover, tend to have a greater sodium and copper requirement, and the grass may contain insufficient to meet the extra demand caused by the increased loss by excretion. Supplementary food to give additional fibre to cattle on highly stimulated pastures can be an advantage, even if the grass contains all the nutrients needed for the animal's level of production. It should be chosen carefully, so that it does not prevent a high intake of grass, and the inclusion of extra sodium, copper and perhaps magnesium may be worth while.

Mr. Dijkstra's paper was the only one dealing with economic aspects. He laid down three conditions that must be fulfilled for the most economical production: (*a*) grass and grass products must be adapted, in the most economical way and along with any purchased feeding-stuffs, to the feeding requirements of the farm livestock; (*b*) the farm equipment, seeds, fertilizers and labour used must be so applied that no greater net output could be obtained by utilizing them in any other line of production; and (*c*) the primary products of the enterprise (grassland products) must be converted as efficiently as possible into the secondary products (milk, meat, etc.). These three conditions are not independent of each other, but have a mutual influence.

There were twelve subsidiary papers in this session, of which two were contributed from the United Kingdom. W. F. Raymond, of the Grassland Research Station, reviewed the problems involved in the "Estimation of Herbage consumed by Grazing Stock". At the Grassland Research Station, as in New Zealand, the fæcal index method is being developed. It is felt that this method is likely to give greater accuracy than others being tried in America; and that from it an estimate of the grazing intake can be made and a measure of the herbage quality obtained. While the technique is simple to operate, it is dependent on adequate sampling, and to this greater attention has still to be given. J. L. Corbett, of the Rowett Research Institute, dealt with "Some Aspects of the Nutrition of Grazing Dairy Cows" and gave details of trials in which the effects of supplementary foods on herbage intake were studied.

Other contributions were from France, Portugal, Switzerland, Belgium, Germany, The Netherlands, Finland and Italy. Dr. L. Seekles, of The Netherlands, dealt with grass or lactation tetany, to which he prefers to give the name 'nutrition tetany'. He criticized the suggestion frequently made that intensively fertilized pasture is a prime cause, since it may occur both on lush pastures and in stall-fed cattle. In addition to the visible symptoms of tetany, there is also gastro-intestinal disfunction. It is possible that certain poisons of intestinal origin interfere with the magnesium-regulating centre in the brain, causing a shift of magnesium from the blood to the tissues. This may be initiated by abnormal functioning of the digestive tract due to its overburdening with excessive food, whether it be lush pasture or other foods. More than one contributor directed attention to the importance of developing the correct bacterial flora for the best digestive utilization of silage. Invariably, animals to which silage is introduced make little or no progress for some time, though later they may recover the lost ground. This appears to be due to the time taken for the correct bacteria for digestion of silage to develop. Further study of this aspect of digestion and of the best utilization of various forages is needed.

A characteristic of both sessions was the vigorous discussion, which was ably directed by the president, Prof. A. M. Leroy. The meeting concluded with the adoption of a resolution calling for intensified research on international lines on the problems of producing a high yield of good-quality grass and of its utilization. There is still, except in some circumstances, a failure to use the full potentiality of the grass crop.

A. R. WANNOP

INSTITUTE OF MEDICAL LABORATORY TECHNOLOGY

SEVENTH TRIENNIAL CONFERENCE

THE seventh triennial conference of the Institute of Medical Laboratory Technology was held in the University of Nottingham during August 29–September 2. In opening the conference, Dr. G. E. Godber, joint deputy chief medical officer to the Ministry of Health, spoke on the development of the pathology services in Great Britain. He began, appropriately, by showing the build-up of laboratory services in the North Midland Region since the beginning of the Second World War, during which the Emergency Pathology Service became the forerunner of the existing network. In spite of war-time improvements, the pathological services over the whole country were far short of requirements when the National Health Service took over in 1948.

Between then and 1954 the amount of pathological work has doubled; almost two thousand technicians and about the same number of student technicians were employed last year in National Health Service laboratories. This increase of laboratory work should be looked upon as part of a process established before the Health Service or even before the War. We have moved from the conception of a hospital which was primarily to provide beds in which patients recovered with varying degrees of assistance from their attendants, to one in which the hospital is a diagnostic and treatment centre, where most patients are out-patients, their needs being met without admission. Admission to the ward is now regarded as a stage in the patient's life and illness which should in his own interests be cut as short as is compatible with speedy and effective cure. Briefly, the hospital is a special kind of service which stands behind, and supports, the great bulk of curative work that is done in other places—surgeries, clinics and the patients' own homes.

Naturally, the bulk of the most complex and highly scientific work is done for patients attending consultative out-patient departments or admitted to the wards. This should not hide the importance of the laboratory's share in diagnosis and treatment in other places, and it is necessary that this side of its work should be expanded. The work of general practitioners is of great importance because so much of it can lead to earlier diagnosis, prevention of serious illness, and the reduction of the load on other departments of the hospital. There is ample evidence that the availability of the pathology laboratory to the general practitioner does not swamp the laboratory with work at the expense of the requirements of the hospital itself: it may even have the opposite effect. That every practitioner should be able to refer his cases direct to the laboratory is a prime necessity.

Speaking of the capital development plan for hospitals, Dr. Godber said that it is commonly believed that a new hospital must necessarily cost more to run than an old one, and it may be that a new one will cost more per bed per year; but if the new hospital makes it possible to treat three patients in the number of bed-days formerly required for two, then there is a margin for increasing cost per patient-day and still reducing the cost per patient treated. A modern pathological service can do much to enhance this process, and particular care is needed in hospital planning to ensure that such departments as pathology and radiology are on a sufficient scale to meet all requirements efficiently and at the same time with economy in man-power.

The laboratory, continued Dr. Godber, is part of the hospital and should not be divorced from it; the clinician relies upon laboratory workers for accurate and expert information which gives him the assurance that enables him to control the complicated armamentarium of treatments. Diagnosis is, after all, rarely a simple process of exact definition and needs a balance of evidence from a variety of sources. Likewise, modern treatments often need the most exacting control, and for these reasons there needs to be close contact between the laboratory and the clinician. Along with the use of more complicated and more accurate apparatus, there has been an increasing devolution of responsibility to the technical staffs of medical laboratories. The Institute of Medical Laboratory Technology has played a great part in facilitating the changes which have taken place in the past few years by its promotion of education and its qualifying examinations and by maintaining and achieving a status for the medical laboratory technician which is now recognized in Britain throughout the national hospital service and all other laboratories.

There were five sessions of scientific lectures at the conference, about two-thirds of which were given by Institute members and the remainder by guest speakers. Dr. M. Lumb spoke on the influence of antibiotics on modern clinical bacteriology; the influence of these substances in the treatment and bacteriology of tuberculosis occupied part of the talk given by Prof. Robert Cruickshank, president of the Institute. Some of the most interesting of the recent problems in this disease have been raised by the type of lesion in which the tubercle bacillus can be demonstrated microscopically but not culturally. Prof. Cruickshank ended his observations with a very necessary warning to laboratory workers. Many laboratories are now handling tuberculous material, and the need for antibiotic control has resulted in a great increase of living culture work. The incidence of the disease in laboratory workers is disturbing, and every possible care should be taken to guard against laboratory infection.

Prof. E. J. W. Barrington, of the Department of Zoology in the University of Nottingham, was able to show a common meeting-ground for those who work in pathology departments and those who work in other specialties, when he spoke of the place of histology in endocrinological research. Certain of the new cytochemical methods, he said, are of equal value in the earthworm and in man. Mr. F. A. Ibbott gave a provocative paper on the error induced in volumetric glassware by drying and sterilization with heat; his own experiments, some of them drastic, have shown that no significant changes were produced by dry heat in certain of his own standard apparatus. Dr. J. C. White, of the Postgraduate Medical School of London, gathered together recent advances in our knowledge of the human hæmoglobins, while Dr. N. P. Burman dealt with methods of detecting and counting antagonistic micro-organisms in soil and described some of his own methods for simplifying a tedious and time-consuming process.

Prof. K. E. Cooper, professor of bacteriology in the University of Bristol, took modern trends in microscopy as his subject and illustrated the principles of phase-contrast, electron and interference microscopy. Speaking of ordinary microscopy, Prof. Cooper deplored the tendency of some workers to set up a very good microscope with a poor illuminating system, so not making full use of their instrument. Mr. J. S. Simpson showed methods employed in the microbiological assay of antibiotics, vitamins and amino-acids, and was able to demonstrate how the use of large sandwiches of agar between glass plates saves the use of considerable quantities of Petri dishes. Dr. G. R. Osborn, director of pathology, Derbyshire Royal Infirmary, gave many examples of the use of modern cytological techniques in the early diagnosis of cancer, and he was followed by Miss M. E. Attwood, who has applied such techniques to the problem of diagnosing uterine carcinoma in particular.

Among other papers were those of Miss V. A. L. Brews, who dealt with electrophoretic patterns of blood sera and the flocculation tests, while Miss E. L. Bown gave a résumé of semi-micro methods used in pædiatric biochemistry. Dr. H. M. Rice, director of pathology, General Hospital, Nottingham, made

observations on the sensitivity of the hæmolytic system in complement fixation tests and showed the greater reliability of modern modifications in the tests, for example, for syphilis. Mr. I. Dunsford, of the Sheffield Blood Transfusion Service, was able to draw on an extensive practical experience in discussing the difficulties encountered when selecting suitable blood for transfusion purposes. His main point was that no one test should be relied upon when cross-matching blood but that saline and albumin techniques should always be employed, with the addition of the Coombs test in cases where there was a risk of the patient having been immunized by previous transfusions or pregnancies.

In addition to these and other papers, numerous demonstrations were on view all the week. For the first time at an Institute conference a large number of foreign laboratory workers were present, and an evening was spent on discussion of matters of common interest. Another innovation was a demonstration for the public who, generally speaking, are not very knowledgeable about what takes place in the hospital laboratory. This demonstration, the result of much co-operation between local pathologists, technicians and many others, was open for only three hours on each of two successive evenings; but the success of the experiment may be judged by the fact that during this short time more than a thousand people visited it.

PRESERVATION OF FOOD BY IONIZING RADIATIONS

THE traditional methods available for the preservation of food are several and varied in their nature. The almost prehistoric method of drying involving the use of solar radiations—unrecognized as such—was the subject of much research some years ago, and this work was very useful to Great Britain during the Second World War when there was a great shortage of shipping space. Some of the chemical preservatives, studied by the 1924 Departmental Committee of the Ministry of Health, often 'blunderbuss' in function, are virtually unused outside the British Isles where those of more recent introduction have been found acceptable both by the industry and the authorities. The availability of antibiotics—some very specific in their action—has created new problems for those who advise our legislators on the desirability of permitting additions to the schedule of preservatives, for such they are. In the realm of food science, experimentation and development, although more sedate in their progress compared with some of the other branches of science, often outstrip the ability of the manufacturers to take advantage of them.

The initial discovery by Röntgen in 1895 that X-rays can damage and destroy living cells has in more recent years been extended over the broader field of ionizing radiations in general. The situation to date, as recorded in various journals mainly of American origin, is that radiations derived from electrical generators, radioactive elements and nuclear reactions are available which exert a lethal effect upon micro-organisms and insects. Parallel with these observations have been reports of reactions initiated by the exposure of food components to such radiations—breakdown of amino-acids, fats, vitamins and so on. The food technologist faced with a new series of units representing the dosage of the product under treatment has often been in difficulty in grasping the significance of the evidence given in these reports, and the very long list of journals in which such reports are sometimes hidden only adds to his confusion. With considerable foresight, the Food Investigation Organization of the Department of Scientific and Industrial Research, as befits its name, has come to the aid of food technologists in providing, through the efforts of Dr. R. S. Hannan, a wealth of information and, let us not delude ourselves, of instruction in its Special Report No. 61 on "Scientific and Technological Problems involved in using Ionizing Radiations for the Preservation of Food"*. The bibliography of some four hundred odd references in this publication will satisfy every collector of reprints and is alone worth every penny of the modest price.

In his survey, Dr. Hannan deals with the ionizing radiations, their generation, their properties and the technical problems associated with their use. Having described the positive advantages of the use of this modern weapon, he very wisely presents for the reader's consideration the various gaps in our knowledge which must be filled before we are able to contemplate using it. The most suitable type of radiation and its optimum dose, the possibility of reactions initiated by such dosage involving the production of undesirable and maybe toxic substances or the destruction of some essential constituent—all these will need to be studied *in extenso* and by teams of workers. We are grateful for the information and for the guidance as to future research, and we look forward to the results of the further researches of Dr. Hannan and his colleagues.

F. H. BANFIELD

* Department of Scientific and Industrial Research. Food Investigation Special Report No. 61: Scientific and Technological Problems involved in using Ionizing Radiations for the Preservation of Food. By Dr. R. S. Hannan. Pp. viii+192. (London: H.M.S.O., 1955.) 7s. 6d.

PHYSICS OF THE IONOSPHERE

THE rapid advances being made in many fields of scientific research leads to a vast amount of published literature in which it is not easy for the student and research worker to discover the real milestones of progress. As a means of partly mitigating this difficulty, there is now an established practice of organizing a conference or symposium at which a particular subject or field of investigation is reviewed and discussed, mainly by those working in the subject. Such a conference forms a suitable focus and also acts as a stimulant to those who otherwise may be rather dilatory in describing their own contributions or putting forward well-founded views on the work of others. The results of such a conference are made of immensely greater value when all the papers which were read and discussed are collected together and published in some recognized standard form.

The conference on "The Physics of the Ionosphere", held under the auspices of the Physical Society at the Cavendish Laboratory, Cambridge, in September 1954 (*Nature*, 174, 866; 1954), meets all these requirements with the publication of the report which is now available*. The report comprises fifty in-

* Physical Society. Report of the Physical Society Conference on the Physics of the Ionosphere, held at the Cavendish Laboratory, Cambridge, September 1954. Pp. iv+406. (London: Physical Society, 1955.) 40s.

dividual papers from authors in Australia, Canada, France, Germany, Great Britain, India, Japan and the United States. It is divided into four parts, each of which is introduced by a survey paper, with a most useful selected list of references.

In the first paper in Part 1, entitled "The Lowest Ionosphere", Prof. A. H. Waynick summarizes the recent radio data which may be used as a guide to the possible physical characteristics of the lowest regions of the ionosphere. These characteristics are primarily concerned with the absorption of short waves and their partial reflexion from the lower ionosphere, and the height of reflexion of very long waves. It is pointed out that great advances in our knowledge of the lower ionosphere is likely to occur in the near future. Recent rocket measurements of X-ray intensities in the neighbourhood of 50 A. suggest that this radiation may well be the primary source of energy associated with the formation of the *E* region. In addition, there now appears to be evidence for postulating the existence of a portion of the *E* region due to meteoric ionization. The remaining nine papers in Part 1 describe work conducted in this field in Great Britain, North America, Germany and India.

The second part of the report, "Irregularities and Movements in the Ionosphere", opens with a survey of existing knowledge by Mr. J. A. Ratcliffe. At all heights in the ionosphere there are randomly distributed irregularities in the electron density. Information on these irregularities—their size, shape and movement—is obtained from a study of the fading characteristics of waves reflected from, or transmitted through, the appropriate part of the ionosphere. The study of the fading observed at spaced receiving stations has contributed greatly to our knowledge of the movement of these irregularities. During recent years, measurements of the propagation of very-high-frequency waves by scattering from the *D* and *E* regions and from auroræ are finding increased application. Observations on the scintillation of radio stars also enable drift movements in the *F* region to be investigated. The sixteen papers collected with the survey in this part of the report form a very complete and up-to-date appreciation of the state of experimental and theoretical knowledge of this subject.

"A Survey of Present Knowledge of the *F*2 Region", by Dr. D. F. Martyn, is the first paper in Part 3, and describes the salient features of the *F*2 region, including the production of its ionization, the recombination coefficients, winds and travelling disturbances, and the storms and anomalies associated with this region. While the other eight papers in this section summarize the present state of knowledge, including theoretical speculation, of conditions in the *F*2 layer, a brief reference is made, in an addendum to the survey, to the wealth of information which was obtained by a rocket ascent in May 1954 to a height of 219 km. A mass-spectrograph was used and data obtained on the composition and pressure in the upper atmosphere. While the results await confirmation, this is undoubtedly an indication of the success of a new technique for exploring the ionosphere.

The fourth and final part of the report deals with "The Mathematics of Wave Propagation through the Ionosphere", and is surveyed by Mr. K. G. Budden. With thirteen other papers, this section describes the mathematical technique used in the study of the properties of the ionosphere, and particularly the variation of ionization density with height, the resulting refractive index and the paths of radio waves in traversing the various ionospheric layers. This section is complementary to the previous three and makes the whole report a comprehensive work of reference which will be of the greatest value to students and research workers for many years to come. The publication of the report must be a very gratifying conclusion to the efforts of Mr. Ratcliffe and his colleagues who were responsible for the conception and organization of this conference.

AUXIN AND PROTOPLASMIC STREAMING

IT has now been known for some considerable time that indoleacetic acid and other growth-regulating substances increase the rate of protoplasmic streaming, but no generally accepted explanation of the phenomenon has yet been advanced. J. M. Kelso and J. S. Turner (*Austral. J. Biol. Sci.*, **8**, 1, 19; 1955) have now reported on the action of various growth-regulating substances on streaming in single cells of the staminal hairs of *Tradescantia virginiana*.

As the rate of protoplasmic streaming in these cells is not affected by change of oxygen concentration in a hanging drop enclosing the hairs over the range 1·5–100 per cent of oxygen in the surrounding gas phase, experiments can be carried out without continuous renewal of the water drop. It was observed that, over the physiological range of concentrations, indoleacetic acid, indolebutyric acid, naphthaleneacetic acid and 2,4-dichlorophenoxyacetic acid, all modify the rate of protoplasmic streaming. These substances, added alone, bring about changes in the rate of streaming within 10 min.; maximum effects are reached in 30 min., and the rates return to the normal in 60–70 min. (exceptions to this rule are noted for naphthaleneacetic acid (high concentrations) and 2,4-dichlorophenoxyacetic acid (low concentrations)). Low concentrations of the auxins stimulate the streaming, high concentrations depress the rate, and intermediate concentrations are without effect.

Auxins thus affect streaming much as they do the growth of stems, the optimal concentrations for stimulation being similar for both processes. The 'total effect' for each growth substance may be estimated as the total extra or diminished distance travelled by a protoplasmic particle in the presence of the applied substance. The maximum positive total effect is given at 1 mgm./l. (1 p.p.m.) for indoleacetic acid and indolebutyric acid, and at 5 mgm./l. for naphthaleneacetic acid. There is a marked *p*H effect for the reaction of streaming to indoleacetic acid, increase in *p*H rendering the applied solution much less effective over the whole range of concentration. The temporary effects of indoleacetic acid on streaming, both stimulation and inhibition, are stabilized near their maximal values, if fructose or malic acid is added with the auxin. These results largely confirm those obtained by Thimann and Sweeney for the *Avena* coleoptile, except that the concentration for indoleacetic acid giving maximal total effect for *Avena* is as low as 0·01 mgm./l. Moreover, for *Avena*, malic acid not only stabilizes the auxin effect but also alters the threshold of response.

COSMIC RADIATION EFFECTS IN METEORITES

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RECENT studies of meteorites[1] showed that they contain an appreciable amount of helium-3 produced by cosmic rays. The interactions of high-energy cosmic-ray particles with the meteoritic matter will produce effects which are propagated to great depths by secondary particles as well as primaries. Nuclei of a wide range of mass numbers less than that of the original should occur in varying proportions, either as evaporation products or as residual nuclei.

We have investigated the production of nuclei of mass 3 and 4[1] (evaporation products); we now report some measurements on the neon isotopes (residual nuclei) in iron meteorites. The data for helium and neon from four irons are given in Table 1.

Because the amount of neon is two orders of magnitude smaller than the amount of helium, only in the case of Thunda was enough neon available for mass-spectrometric analysis; the precision of this analysis is better than 5 per cent. The measurement is complicated by the presence of instrumental background peaks at mass 20 and 22, due to $H_2{}^{18}O^+$ and $CO_2{}^{++}$ respectively. The former was considerably reduced by replacing oxygen-18 by oxygen-16, the latter by using an (electron) ionizing voltage of 35 V. The method of helium and neon separation has been described elsewhere[2], but special care was taken to remove adsorbed atmospheric neon from the containing vessel before commencing dissolution of the meteorite sample. The amount of atmospheric neon contamination was less than 10^{-9} c.c., which represented less than 1 per cent of the meteoric neon finally measured.

It would appear from the isotopic analysis of the extracted neon that all its isotopes arise from the original iron nuclei after the direct ejection and evaporation of nucleons are completed. Such events as these are the 'stars' recorded in photographic emulsions exposed at high altitudes; and we have used the statistical data obtained from photographic plates to estimate the rate of production of neon by cosmic radiation. The degradation of the iron nucleus ($Z = 26$) to neon ($Z = 10$) involves the emission of 16 units of charge from the parent; but since some of the emitted particles will carry a multiple charge (helium nuclei), it seems, taking the He/p ratio of about 0·3 derived by evaporation theory[3], that the events with which we are concerned will appear on the photographic plate as stars of about thirteen prongs. Taking the rate of star production by cosmic rays in photographic emulsions as about 2,500 stars/c.c./day at the top of the atmosphere[4], this is increased by a factor of 2 to give the rate of production in iron, and by a further factor of 2 to obtain the rate away from the earth's shielding effect. From the data given by Lord[4], it would seem that about 2 per cent of the total stars produced are thirteen-pronged events. Even if any cut-off of low-energy particles due to the earth's magnetic field does exist, one would not expect the figure of 2 per cent of the total stars giving neon to be very much altered in space, since only high-energy particles will give rise to thirteen-pronged events. Thus we calculate a rate of production of neon of about twenty-five neon atoms/gm. iron/day. In addition, one would expect the isotopes sodium-20, 21 and 22, and fluorine-20 and 21 to be produced in such quantities that, in decaying into a neon isotope, and more than replacing the loss due to neon-19 and 23, they will approximately double the yield of neon, making a total of fifty neon atoms/gm. iron/day.

We have already suggested[5] the possibility that the cataclysmic break-up of a parent planet formed the meteorite fragments about 2×10^8 years ago. On the basis of the above data, one would expect the neon produced in an unshielded fragment to be about $1{\cdot}35 \times 10^{-7}$ c.c./gm. iron, and the isotopic composition and large yield of the helium extracted from our sample of Thunda would indicate that this piece was relatively unshielded from the cosmic radiation. Since it seems that the helium-3 and neon in a meteorite are all produced by cosmic radiation, one would expect approximately the same ratio of neon to helium-3 in any unshielded sample. This ratio for the four samples concerned is given in Table 1 and the values obtained prove to be closely similar. The calculations of Le Couteur[3] suggest that about 37 per cent of the total yield of particles from 'evaporation stars' will be in the form of helium-4, helium-3, or tritium, all of which will be recorded as helium after a suitable lapse of time. Taking the average number of prongs per star as ten at the average cosmic-ray energy concerned, and using the measured ratio ($^3He + {}^3H$)/^4He of 30 per cent, we can deduce a figure of about a hundred atoms of ($^3He + {}^3H$) per hundred stars. (The tritium we eventually measure as helium-3.) Using again the figure mentioned above of two to four neon atoms per hundred stars, we would expect the neon/helium-3 ratio to be between 2 and 4 per cent, comparing favourably with the measured value.

Table 1

Meteorite	Helium (10^{-6} c.c./gm.)	Neon (10^{-9} c.c./gm.)	Ratio He/Ne	$^3He/^4He$ (per cent)	$Ne/^3He$ (per cent)	Per cent neon- 20	21	22
Thunda	29·05	18·9	154	30·7	2·71	43	36	21
Toluca (Durham)	18·6	11·4	164	29·7	2·69			
Carbo (3 cm.)	20·94	12·3	171	28·8	2·63			
Carbo (0·5 cm.)	22·36	13·2	169	28·4	2·69			

We have also compared our results with those obtained from recent laboratory experiments on high-energy reactions induced by protons in copper[6]. In Table 2 are listed the estimated production cross-sections (from copper) of the

Table 2

Isotope	Estimated cross-sections (m.barns)
Sodium-20	0·6
Sodium-21	1·0
Sodium-22	2·0
Neon-20	4·0
Neon-21	3·0
Neon-22	2·5
Fluorine-20	2·5
Fluorine-21	0·5

nuclear species which end in neon isotopes. The variation of cross-section with Z for a given element was estimated from the average shape of the curve for all neighbouring elements, as discussed by Batzel *et al.*[6].

Taking these values, the isotopic composition of the neon produced should be: neon-20, 44 per cent; neon-21 and neon-22, 28 per cent. Our measured isotopic ratios given in Table 1 are in reasonable agreement with these estimates, considering the uncertainties in the cross-sections, and in the energy spectrum of the cosmic rays.

With the data of Table 2 we may make an independent calculation of the rate of production of neon. Because we are considering reactions in iron (8 mass units from copper), we increase the cross-section values by 20 per cent; that is, we take 20 m.barns as the total cross-section for neon production. For a cosmic-ray intensity[4] of 0·3 particle/cm.^{2}/sec./sterad., $2{\cdot}6 \times 10^4$ atoms of neon are produced per gm. of iron per year; or in 2×10^9 years, about 2×10^{-7} c.c. neon/gm. iron, a value once again close to the measured neon content.

It seems that the cosmic radiation to which the fragments have been subjected since the parent was broken up has produced measurable quantities of many nuclides lighter than iron, the study of which should lead to a better understanding of the radiation and the high-energy processes involved. We are continuing our investigations, particularly for samples of greater depth, and extending them to cosmogenic argon.

We would expect that the events which produce argon ($Z = 18$) from iron ($Z = 26$) would appear as six- or seven-pronged stars, and again using the data of Lord[4], we find that argon should be produced about four to five times as abundantly as neon, suggesting a cosmogenic argon content for unshielded meteoritic iron samples of about 6×10^{-7} c.c./gm. In addition, it is to be expected that the isotopic composition of cosmogenic argon would differ markedly from that of atmospheric argon, with argon-36 and argon-38 much more predominant in the former source than in the latter.

If this proves to be correct, it should be possible to predict the amount of many other cosmogenic isotopes in meteorites, and to decide which of these will lend themselves most readily to experimental determination.

We are grateful to Dr. W. O. Lock and Dr. S. J. Goldsack, of the University of Birmingham, who helped to interpret the photographic emulsion data; and to Dr. J. L. Symonds, of the University of Birmingham, who provided the data derived from high-energy proton-induced reactions. We would also thank Prof. F. A. Paneth for his interest in the work and for providing samples of meteorites.

[Aug. 23

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MECHANISM OF SOME REDUCTION PROCESSES ILLUSTRATED ON A COENZYME I MODEL SUBSTANCE

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THE enzymatic reduction of coenzyme I (diphosphopyridine nucleotide) has been the subject of many investigations and discussions recently[1]. The product obtained by reducing coenzyme I with hydrosulphite can be reoxidized enzymatically, as of course can the reduced coenzyme I formed by enzymatic reduction. It was recently shown that the reduction product obtained[2] from coenzyme I when reactive intermediates produced from, for example, ethanol in irradiated aqueous solutions were used as the reducing agents was not identical with the product of hydrosulphite reduction[3]. This reduction product was enzymatically totally inactive. Borohydride reduction yields a product which could be reoxidized enzymatically to the extent of about 50 per cent[4].

The chemistry of these processes has been investigated on N′-alkyl nicotinamide derivatives, which represent the active group of coenzyme I[5]. Karrer[6] isolated the hydrosulphite reduction products of several such derivatives and compared them with reduced coenzyme I, which they resembled closely. Such a substance was used in electrolytic and polarographic investigations of coenzyme I model systems[7,8].

Using such a model substance, it was also shown[2] that as, in the case of coenzyme I, when reactive intermediates formed in irradiated aqueous solutions were used as the reducing agent, a reduction product is obtained which is closely related to, but not identical with, the product of hydrosulphite reduction.

The work of Colowick[9] and Swallow (results in the press) indicate that the enzymatic and hydrosulphite reductions of coenzyme I proceed not through a free-radical intermediate, as sometimes assumed, but through an ionic addition mechanism. On the other hand, the mode of action in the irradiated system was assumed[9,10,11] to be due to the intermediate formation of free radicals. The ionizing radiation would in the main act on the bulk of the aqueous solvent, producing radicals according to[12]:

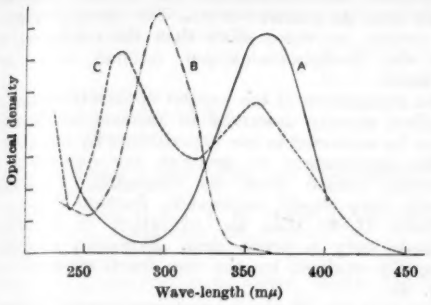

Fig. 1. Absorption spectra of: (*A*) product of hydrosulphite reduction; (*B*) product of acid treatment; (*C*) product of reduction in irradiated solution. Optical density in arbitrary units

$$HOH \rightarrow H + OH \qquad (1)$$

OH radicals attack the ethanol according to:

$$RH_2 + OH \rightarrow \dot{R}H + HOH \qquad (2)$$

The organic free radicals, $\dot{R}H$, thus formed are apparently efficient reducing agents of coenzyme I, themselves being oxidized to acetaldehyde.

Thus it appeared possible that, in the present case, closely related but not identical products are produced through different mechanisms of reduction. Accordingly, using nicotinamide-N′-propyl iodide as the model substance, we have examined some modes of reduction.

Using hydrosulphite, a pure crystalline reduction product could be isolated, melting point 86° C. Elementary analysis and oxidative titration showed it to be a dihydro-isomer. The absorption spectrum of the product in carbonate alkaline solution is shown in Fig. 1, curve *A*. In acid solution the spectrum changes to that shown in Fig. 1, curve *B*.

On irradiation with X-rays in aqueous solution (ref. 3 and unpublished work by the authors and Swallow) containing 0·5 *M* ethanol and approximately 10^{-3} *M* nicotinamide-N′-propyl iodide, another product was obtained, the spectrum of which is shown in Fig. 1, curve *C*. The product isolated was crystalline, melting point 99–103° C. Elementary analysis and oxidative titration indicated that it is a dihydro compound. In acid solution it gave a spectrum as shown in Fig. 1, curve *B*, identical in all respects with that obtained from the other product.

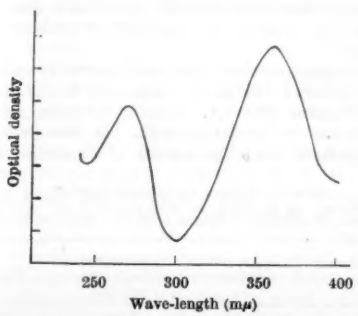

Fig. 2. Absorption spectrum of product of borohydride reduction, before resolution into components. Optical density in arbitrary units

In view of these findings, it was of interest to investigate the results of borohydride reduction. Here, in the case of coenzyme I, a product exhibiting enzymatic behaviour midway between the products obtained by the other two methods is obtained. On borohydride reduction of the nicotinamide we obtained a product having the spectrum shown in Fig. 2, a composite of the other two. From the product two pure components could be separated. One, a crystalline product having melting point 103° C., gave a spectrum like Fig. 1, curve *C*, whereas the other gave a spectrum like Fig. 1, curve *A*. Thus borohydride reduction apparently gives a mixture of the products obtained by the other two methods.

Regarding the product of electrolytic reduction, Leach[7] obtained the E^0 values of the product in solution, but did not isolate it. Fundamental work on the mechanism of organic electrolytic reduction processes became available recently[12], indicating that in this method radical intermediates may result.

On electrolytic reduction of nicotinamide-N′-propyl iodide in alkaline carbonate solution, a product was obtained the spectrum of which is identical with that of the radiation product and one of the borohydride products, as shown in Fig. 1, curve *C*.

We find, then, that electrolytic and radiation reduction, both of which are assumed to proceed by a free-radical intermediate, yield the same dihydro derivative. Hydrosulphite reduction, proceeding by an ionic addition intermediate, yields another dihydro derivative. Borohydride, the mode of operation of which is not entirely certain yet, but is often assumed to involve hydride (H^-) ions, yields a mixture of two such derivatives, which can be separated into its components.

If Pullman's[14] views are accepted and if hydrosulphite does indeed yield the same isomer as the enzymatic process, as is often assumed, then the product of these two methods would be the *para*-dihydro isomer. Two *ortho*-dihydro isomers are possible, and judging by the behaviour of the N′-alkyl nicotinamide models, Karrer thought the enzymatic product to be an *ortho*-dihydro derivative.

We hope to gain further information on this point from an investigation now in progress in collaboration with Dr. A. J. Swallow (unpublished work), whom we thank for valuable discussions and co-operation. The radiation chemical aspects of the present work and of work on some other systems of biological interest are being reported separately[11].

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Respiratory Chain Phosphorylation in Extracts of *Azotobacter vinelandii*

Respiratory chain phosphorylation has been demonstrated in crude extracts of a few bacterial species[1–4], and in one case the extract was separated into three components which were all necessary for phosphorylation coupled with the oxidation of reduced diphosphopyridine nucleotide[3]. However, the elements supporting the system of enzymes responsible for oxidative phosphorylation in bacterial cells is still unknown. The present communication describes some preliminary experiments in which a crude water-extract from *Azotobacter vinelandii* was fractionated by high-speed centrifugation into particles and 'soluble' fractions. This organism was chosen because it is strictly aerobic (cf. ref. 2) and has a very high respiratory activity.

The extract was prepared essentially according to a procedure already described[5]. In Table 1, fraction *P* consists of particles not sedimented by 20 min. centrifugation at 10,000 *g*, but sedimented at about 120,000 *g* for 90 min. Fraction *S* is the clear supernatant taken from the top of the tube, after the high-speed centrifugation. The small particles oxidized succinate with phosphorylation, the phosphorus/oxygen (atoms) ratios varying between 0·14 and 0·87 in the experiments reported in Table 1. The reason for the wide variation between different preparations is not known; it is not due to instability of the enzyme systems in the extract, since neither the oxygen uptake nor the esterification of phosphate were affected by standing 24 hr. at 4° C. or 10 min. at 25° C. Fraction *S*, which contains proteins of molecular weight less than 10^6, possesses considerable 'soluble' succinic oxidase activity, especially in exp. 1, with some phosphorylation. When the two fractions were mixed, both the oxygen uptake and the phosphorylation were stimulated far beyond that expected from an additive effect. The phosphorylation was usually increased more than the oxidation, so that the phosphorus/oxygen (atoms) ratio was increased.

The stimulation of the oxygen uptake is similar to an effect already described in extracts of *E. coli*[6]. It can be explained in our experiments by the ability of the supernatant to promote the oxidation of fumarate formed from the succinate. Fumarate is only very slowly oxidized by fraction *P* (exp. 3 in Table 1), so that the oxidation of succinate proceeds only a single step. However, fumarate is rapidly oxidized by the two fractions combined (exp. 4).

The increase of the phosphorus/oxygen (atoms) ratio brought about by adding fraction *S* to fraction *P* is partly explained by the fact that the proportion of the total oxygen uptake which is associated with the succinate → fumarate step, a reaction yielding relatively little phosphorylation, is decreased. However, it is unlikely that this is the complete explanation. Dialysis of fraction *S* had a marked effect on the phosphorylation, with relatively little action on the oxygen uptake. Heating fraction *S* abolished its activating effect. It is possible that fraction *S* contains soluble enzyme(s) and coenzyme(s) which may activate the relatively deficient particles in fraction *P*. This can be tested by further fractionation of fraction *S*.

The phosphorylation was only partially inhibited by dinitrophenol (Table 2). Pinchot[3] found that the phosphorylation with *A. faecalis* extracts was also little affected by dinitrophenol. It has previously been suggested[7] that the action of dinitrophenol on

Table 1. Oxidative Phosphorylation in Extracts of *Azotobacter vinelandii*

See text for method of preparation of fractions. In experiments 2–4, fraction *P* was washed by resuspending in 0·05 *M* phosphate, *p*H 7·0, and repeating the high-speed centrifugation.

Reaction mixture: phosphate, *p*H 7·4, 0·04 *M*; magnesium, 0·005 *M*; adenosine monophosphate, 6×10^{-4} *M*; adenosine diphosphate, 6×10^{-4} *M*; glucose, 0·03 *M*; versene, 0·001 *M*; succinate, 0·02 *M*, or fumarate, 0·005 *M*; hexokinase. In experiments 2, 3 and 4, fluoride (0·04 *M*) was present. Reaction volume, 1 ml., 25° C., 30 min. Δ (esterified phosphorus) and (oxaloacetate + pyruvate) measured as described previously (ref. 8)

Exp.	Fraction	Protein (mgm.)	Substrate	Oxygen uptake (μ atoms)	Δ (esterified phosphorus) (μmoles)	P : O	Δ (oxaloacetate + pyruvate) (μmoles)
1	*P*	0·35	Succinate	1·37	1·19	0·87	—
	S	9·4	Succinate	3·61	0·56	0·16	—
	P + *S*	9·7	Succinate	11·9	5·42	0·46	—
2	*P*	1·5	Succinate	2·10	0·49	0·23	0·13
	S	12	Succinate	0·67	0·22	0·33	0
	P + *S*	13·5	Succinate	6·94	2·32	0·33	0·08
3	*P*	1·2	Succinate	3·78	0·52	0·14	0·03
	P	1·2	Fumarate	0·16	0·02	—	0·06
4	*P*	0·7	Succinate	1·80	0·45	0·25	0·02
	S	5·0	Succinate	0·61	0·14	0·22	0
	P + *S*	5·7	Succinate	3·35	1·41	0·42	0·05
	P + *S*	5·7	Fumarate	6·90	2·83	0·41	2·25
	P + *S**	—	Succinate	2·84	0·81	0·29	0·04
	P + *S*†	—	Succinate	1·94	0·48	0·25	0·07

* Dialysed against 0·05 *M* phosphate, *p*H 7·0, at 4° C., for 2 hr.
† Heated 100° C., 3 min., centrifuged, and supernatant used.

Table 2. Effect of Dinitrophenol

Reaction mixture as in Table 1, with succinate as substrate and fluoride added. Fraction *P* (0·7 mgm. protein) + fraction *S* (4·8 mgm.)

Dinitrophenol (*M*)	Oxygen uptake (μ atoms)	Δ (esterified phosphorus) (μmoles)	P : O
0	4·35	1·74	0·40
3×10^{-5}	4·26	1·29	0·30
10^{-4}	3·72	0·96	0·26

mitochondrial phosphorylation might be indirect. It may not be revealed in the very small particles in extracts of micro-organisms.

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Isolation of Δ^9 Heptadecenoic Acid from Lamb Caul Fat

APART from the fats of dolphins and porpoises, which contain considerable proportions of *iso*valeric acid, it has been customary to regard animal fats as consisting of triglycerides of straight-chain even-numbered carbon saturated and unsaturated fatty acids. However, recent work in this laboratory has shown that there occur also trace amounts (up to 1·0 per cent) of saturated fatty acids in the form of odd-numbered *iso*-acids and *ante-iso*-acids[1], even-numbered *iso*-acids[2], polybranched acids[3] and odd-numbered straight-chain acids[4]. Odd-numbered straight-chain unsaturated acids, however, have not hitherto been found in natural fats.

Appel, Böhm, Keil and Schiller[5] have earlier shown that when synthetic fats containing odd-numbered carbon saturated *n*-fatty acids within the range C_9–C_{19} are fed, these acids are deposited in animal fats, including the depot fats of the goat and the rat, and the milk fat of sheep. Moreover, the animal is able to desaturate these acids so that, in addition to the presence of odd-numbered saturated *n*-acids, there are also found the corresponding Δ^9-unsaturated fatty acids within the range C_{11}–C_{19} inclusive. In view of the ability of the animal to dehydrogenate odd-numbered *n*-fatty acids, it could be anticipated that having established the occurrence of uneven-numbered carbon straight-chain fatty acids in natural fats[4], the corresponding Δ^9-unsaturated fatty acids would also be found. This is now confirmed by recent work in this laboratory.

The methyl esters of the liquids (1,054 gm.) prepared by crystallization three times from ten volumes of acetone of the mixed fatty acids of lamb caul fat (2,578 gm.) at − 35° were fractionally distilled *in vacuo* to yield a fraction *L*2,6, 41·5 gm., sap. equiv. 284·4, iodine value 65·8, $[\alpha]_D^{23.3}$° + 0·99. After removal of the more saturated constituents by crystallization of the acids (36·90 gm.) from 40 volumes of light petroleum (b.p. 40–60°) three times at − 40°, the soluble portion, 28·16 gm., iodine value 88·9, $[\alpha]_D^{23}$ + 0·44, was converted to methyl esters and subjected to repeated fractional distillation to remove the methyl esters of C_{16} and C_{18} acids. Eventually, there was obtained a fraction (7·94 gm.) consisting almost entirely of methyl esters of C_{17}-acids. Repeated low-temperature crystallization of the acids (6·68 gm.) from acetone resulted in the following fractions arranged in order of increasing solubility:

Fraction		Iodine value
1	1·21 gm.	13·4
2	1·05	72·4
3	1·19	74·7
4	1·03	80·9
5	1·38	99·2
6	0·532	119·9

Fractions 2, 3 and 4 were combined, and after conversion to methyl esters (3·09 gm.) were chromatographed on a 30-mm. diameter column packed with a mixture containing 106 gm. silica gel and 26 gm. of 'Celite'. Fourteen fractions were eluted with petroleum ether and the residue with methyl alcohol. Of these fractions, 1–6 were of relatively high melting point and showed optical rotation. Fractions 7–13 melted within the range of − 32° to − 30·5° showed negligible optical rotation and were therefore bulked, giving 1·846 gm. Hydrogenation of 0·30 gm. on conversion to the acid (0·25 gm.) had a melting point of 59·9–60·5°. When admixed with authentic margaric acid of melting point 60·8–61·0°, the mixture melted at 60·0–60·6°. Oxidation of 0·403 gm. with 2 gm. finely powdered potassium permanganate in acetic acid at 50° C. gave 0·078 gm. of unoxidized material. From the oxidation products insoluble in light petroleum there was obtained on crystallization from water 0·100 gm. of acidic products, melting point 102–103·5°, saponification equivalent 94·1. On admixture with authentic azelaic acid, melting point 104·5–105·5°, the melting point was raised to 103–104°. These results accord with the presence of Δ^9-heptadecenoic acid in lamb caul fat.

In the present sample, the iodine values of the methyl esters of the liquids corresponding to those of C_{17}-acids was unusually high (65·8). In another sample of mutton tallow from older animals the iodine value associated with the C_{17}-fraction was of the order of 15, which suggests that the ratio of unsaturated to saturated C_{17}-acids shows a wide variation. In the sample under examination the iodine value of the C_{18}-fraction was of the order of 12 units, showing that the C_{18}-acids had been much less desaturated than the C_{17}-acids.

It is therefore concluded that, in addition to the types of fatty constituents mentioned above, it is likely from the evidence provided that there occurs also in natural fats a series of straight-chain Δ^9-unsaturated fatty acids with an uneven number of carbon atoms.

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Molecular Weight of Ovalbumin and of Bovine Serum Albumin in Urea Solution

Since 1902, when Ramsden[1] described the effects of urea on "proteids", there has been much speculation regarding the molecular weights of proteins in urea solution. Some workers have claimed that aggregation does not take place in the urea denaturation of ovalbumin and bovine serum albumin. In spite of this, it is well known that their urea solutions frequently form gels when the protein concentration is high. Recently, Kauzmann *et al.*[2,3] have studied the viscosity changes accompanying the urea denaturation of these proteins and the gelling time for ovalbumin. Under certain conditions an aggregation dependent upon concentration occurred, and this was interpreted in terms of hydrogen bonding and intermolecular disulphide bonds (the latter through the —SS— and —SH exchange reaction of Huggins, Tapley and Jensen[4]).

During the past three years, a physicochemical study has been made in this laboratory of proteins in urea solution. Observations on sedimentation and diffusion for ovalbumin and bovine serum albumin are briefly reported here. Data for the denaturation of 1 per cent (w/v) protein in 7 *M* urea (with buffer and sodium chloride to Γ/2 of 0·1) at 25° C. are summarized in Table 1. Sedimentation coefficients (s) and diffusion coefficients (D) are given in c.g.s. units and have been multiplied by 10^{-13} and 10^{-7} respectively, and refer to the urea solvent at 25° C. unless otherwise stated. Where molecular weights have been calculated, the partial specific volume was taken to be the same as the native protein (the justification for this will be given elsewhere). The molecular weight of native ovalbumin was determined to be 39,000 ($s_{20,w} = 3{\cdot}11$, for 0·5 per cent; $D_{20,w} = 7{\cdot}67$) and bovine serum albumin 68,000 ($s_{20,w} = 4{\cdot}07$, for 1 per cent; $D_{20,w} = 5{\cdot}49$) in agreement with other workers[5].

Table 1. Sedimentation and Diffusion

Ovalbumin		Serum albumin	
*p*H	Homogeneity	*p*H	Homogeneity
3·3	Homogeneous. No aggregation. $s = 0{\cdot}66$ ($s_{20,w} = 1{\cdot}36$). $D = 2{\cdot}33$. Mol. wt. = 42,000	3·6	Homogeneous. No aggregation. s, D will be discussed elsewhere
6·2	Heterogeneous. Progressive increase of faster components with time. $s = 0{\cdot}8$ and 2·1 to 4·5 (peaks diffuse)	6·4	Homogeneous. No aggregation. $s = 1{\cdot}20$ ($s_{20,w} = 2{\cdot}43$). $D = 2{\cdot}21$. Mol. wt. = 71,000
9·4	Heterogeneous. $s = 0{\cdot}8$ and 1·5. Sedimentation peaks diffuse. Aggregation not eliminated by —SH reagent but sedimentation peaks sharpened	9·5	Very little aggregation after 4 hr. reaction. Increasing heterogeneity after 26 hr. Aggregation eliminated by —SH reagent

The results in Table 1 (supported by optical rotation studies) suggest that unfolding (or swelling) of these proteins occurs in urea solution. At certain *p*H values this is followed by aggregation.

The extent to which the aggregation reaction could be blocked by cysteine and *p*-chlormercuribenzoate was also investigated. At *p*H 6·7, 0·02 *M* cysteine had no effect on the aggregation of ovalbumin in 7 *M* urea, in accordance with expectation (cf. ref. 2, p. 5169); at *p*H 8·3 it caused considerable sharpening of the two sedimentation peaks. The effect of 0·005 *M* *p*-chlormercuribenzoate at *p*H 9·1 was similar. The molecular weight of the aggregate in the presence of the —SH reagent was estimated to be 150,000–250,000 and therefore consists of four to six molecules of ovalbumin. The behaviour of serum albumin in the presence of —SH reagent was quite different. At *p*H 9 the protein was homogeneous by sedimentation and diffusion. The molecular weight (60,000, $s = 0{\cdot}98$ and $D = 2{\cdot}33$) was virtually the same as the native protein.

Considering our results with the previous work[1,4], there are evidently at least two kinds of aggregation reactions possible for ovalbumin in 7 *M* urea. The exchange reaction of —SS— and —SH groups seems to be less important than the other one (probably hydrogen bonding[3]). In the case of bovine serum albumin, aggregation only occurs through the exchange reaction. Further details of the results for these and other proteins will be described elsewhere.

One of us (R. G. W.) is grateful to the Commonwealth Scientific and Industrial Research Organization for the award of a studentship. This work forms part of the food preservation investigations of this Organization.

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Some Differences in the Effects of Different Sympathomimetic Amines on the Isolated Innervated Rat Diaphragm Preparation

When the electrically stimulated contractions of the isolated innervated rat diaphragm preparation are depressed by extra potassium chloride in Krebs solution, addition of adrenaline produces recovery[1,2]. Further, when mixtures of adrenaline and potassium chloride are added to preparations already depressed by extra potassium, 0·2 μgm. adrenaline antagonizes as much as 5 mgm. of the chloride[2]. The approximate amounts of twelve different sympathomimetic amines needed to antagonize in this way 5 mgm. potassium chloride have now been found; they are shown, relative to adrenaline as unity, in Table 1, together with the formulæ of the amines.

Unexpectedly, 500 μgm./50 ml. methedrine hydrochloride, or 800 μgm. amphetamine sulphate, increased rather than reduced the depression due to potassium chloride, and with larger doses (2–5 mgm.) of methedrine or benzedrine the increase was very rapid. 500 μgm. pholedrine or tyramine had no visible effect within 5 or 10 minutes. When added alone, the different doses of the different sympathomimetic amines required to antagonize 5 mgm. potassium chloride did not produce equal amounts of recovery; the amines which antagonized less potassium chloride than adrenaline generally pro-

Table 1

Sympathomimetic amine	Relative No. of molecules needed to antagonize 5 mgm. pot. chloride	Structure R_1	R_2	R_3	R_4	R_5
isoPrenaline sulphate	0·2	OH	OH	OH	H	$(CH_3)_2$
1-Adrenaline bitartrate	1	OH	OH	OH	H	CH_3
Cobefrin hydrochloride*	35	OH	OH	OH	CH_3	H
1-*nor*Adrenaline bitartrate	45	OH	OH	OH	H	H
Epinine hydrochloride	70	OH	OH	H	H	CH_3
1-Phenylephrine hydrochloride	275	H	OH	OH	H	CH_3
Ephedrine hydrochloride	2,500	H	H	OH	CH_3	CH_3
Synephrine bitartrate	2,600	OH	H	OH	H	CH_3
Pholedrine sulphate	—	OH	H	H	CH_3	CH_3
Tyramine hydrochloride	—	OH	H	H	H	H
Amphetamine sulphate	—	H	H	H	CH_3	H
Methedrine hydrochloride	—	H	H	H	CH_3	CH_3

* I am grateful to Bayer Products, Ltd., for a gift of this compound.

duced larger recoveries than might have been expected from these antagonisms. For example, although about 2,500 times as much ephedrine as adrenaline is needed to antagonize 5 mgm. potassium chloride, about 100 times as much ephedrine as adrenaline produced equal recovery. This may be due to a slower rate of recovery produced, for example, by ephedrine.

Adsorption of adrenaline at specific receptor surfaces probably occurs prior to its effect on the contractions[3,4]. Preliminary attempts have been made to determine the amount of this adsorption: ½–2 min. after adding 1–5 μgm. adrenaline to a 50-ml. bath in which a rat diaphragm was suspended, 1–5 ml. solution was withdrawn and adrenaline estimated in the solution by the ethylene diamine method[5], without prior passage of the solution over alumina; 10 per cent of the adrenaline had disappeared from the solution. As adrenaline is not differentiated from adrenochrome when alumina is not used, the 'losses' of adrenaline may have been due to its transfer to the muscle rather than to its oxidation. If this is the case, and if the volume of the surface phase of the preparation is taken, with various assumptions[3], as 10^{-3} ml., the ratio of the concentrations of adrenaline in the surface and bulk phases of the solution would have averaged 10^3–10^4, a figure in reasonable agreement with the minimum value (2×10^5), calculated from theoretical considerations by Danielli[3]. The amines with the most OH groups are the most effective in antagonizing potassium chloride and in producing recovery; this influence of polar groups is presumably related to the chemical configuration of the receptors.

Experiments carried out with the rat diaphragm preparation in normal Krebs solution and in solution containing only 0·5 m*M* calcium ions show that in these solutions the effects on the contractions due to methedrine and benzedrine are the same in direction as those of 2 μgm./50 ml. adrenaline, but are more prolonged; thus, 4–6 mgm. methedrine or benzedrine augmented the contractions in normal Krebs solution; in 400 μgm. doses they had no effect. In the solution low in calcium ions, there is partial neuromuscular block and this is temporarily increased by 2 μgm. adrenaline[6,7]; a subsequent 50-μgm. dose facilitates transmission[7]. Increased block was produced in varying amounts by other amines; for example, 4 mgm. methedrine or 6 mgm. benzedrine rapidly and completely blocked neuromuscular transmission and, also like adrenaline, slightly depressed the response to direct stimulation; unlike adrenaline, these effects were prolonged. 1 mgm. methedrine produced a slower block; no facilitation has so far been observed with these amines.

Obviously the depressant effect of 500 μgm./50 ml. methedrine in muscles depressed by extra potassium chloride, in which adrenaline produces recovery, cannot be due to prolonging of the action of adrenaline, and it is very unlikely to be due to the fairly high dosage of methedrine used: larger amounts of ephedrine augment the contractions in these circumstances, as do larger doses of methedrine in normal Krebs solution. It is even more unlikely that methedrine acts in a very different way from adrenaline on skeletal muscle. It is possible that the sometimes different effects of adrenaline and methedrine might be due to some difference in a single reaction; it is more probable, however, that redistribution of potassium[8] and of calcium[7], and other changes affecting the contractions which are produced by adrenaline, are the resultant of more than one reaction, chemical or physical, brought about by adrenaline. Further work with different sympathomimetic amines should be of interest with regard to the mechanism of action of these drugs.

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Single-Breath Continuous Carbon Dioxide Analysis

MEASUREMENTS of inequalities in alveolar ventilation and of physiological dead space give an estimate of the under-ventilated and under-perfused volumes of diseased lungs. Comroe and Fowler[1] described the use of a nitrogen meter to detect uneven alveolar ventilation during a single expiration. Dubois *et al.*[2] showed how the physiological dead space could be assessed by measuring the carbon dioxide content of expired air with a rapid infra-red gas-analyser, and Dornhorst *et al.*[3] described the pattern produced, with similar apparatus, by emphysematous patients. This method relates the carbon dioxide content of expired air to time, and the records produced are sometimes difficult to interpret because the carbon dioxide content is also influenced by the volume of air expired. Marshall *et al.*[4] demonstrated the relation between volume and carbon dioxide content of expired air by fractional analysis and applied their method to normal and diseased subjects.

We have modified the method of Dornhorst *et al.*[3] so as to plot directly the carbon dioxide content against the volume expired. The expiratory flow-rate is also demonstrated. A single expiration is made into a Benedict spirometer which has a potentiometer attached to the pulley. The change in volume is displayed on the horizontal axis of a cathode-ray oscilloscope trace. The spot of the oscilloscope is at the same time influenced in the vertical axis by a 6-c./sec. a.c. signal from an infra-red carbon dioxide analyser. This is fed with air which is taken from just beyond the mouth, circulated through the analyser, and returned to the spirometer by a small electric pump. The graph of carbon dioxide content against volume for one expiration is photographed on a stationary film. The delay of the analyser can be reduced to one-third of a second and can be allowed for in reading the records, being represented by two strokes of the a.c. signal.

The normal record (Fig. 1) consists of a horizontal line representing dead space, followed by a rapid rise to a flat plateau of alveolar air. The abnormal record, illustrated in Fig. 2, is from a patient with advanced pulmonary fibrosis and emphysema. It can be divided into three phases: the horizontal initial line; a steeply sloping portion from poorly perfused lung, the volume of which can be substantially reduced by holding the breath beforehand, and from which physiological dead space can be estimated; and finally, a gently sloping portion which is very similar to the records obtained by Comroe and Fowler[1] and therefore probably reflects uneven alveolar ventilation. In other patients with emphysema, the horizontal phase may be followed by a rapid rise to the final sloping phase.

It causes the subject very little discomfort or inconvenience to obtain such a record, and the apparatus is commercially available. Abnormalities are immediately recognizable and the a.c. signal provides a time-scale from which the expiratory flow-rate can be calculated.

We are comparing records so produced with other methods of estimating pulmonary function and are planning to make records from the two lungs separately through a Carlens catheter.

We are grateful to the Gateshead Hospital Management Committee for the purchase of the apparatus, to the Newcastle Regional Board Research Committee for a grant for technical assistance, and to Mr. J. T. Kennair, who gave much technical advice. The carbon dioxide analyser was supplied by the Infra-red Development Co., Ltd.

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Inhibition of the Production of Precipitating Antibodies in Young Rabbits

The failure of rabbits to develop antibody to bovine serum albumin when injected with this antigen at an early age was recently reported by Hanan and Oyama[1]. Similar results have been reported by Buxton[2], who found there was no antibody response to killed *Salmonella pullorum* in fowls after they had been exposed to this organism as embryos and young chicks. The studies of Hanan and Oyama[1] suggest that the responses to closely related antigens may also be impaired in rabbits that exhibit inhibition. If, however, rabbits that failed to develop antibodies to one antigen were capable of producing antibodies to a closely related one, the value of such antisera in systematic serology and similar fields would be apparent. Preliminary results of pre- and post-natal exposure of rabbits to parenteral administration of whole chicken serum are reported in this communication.

Two pregnant rabbits were obtained thirty days before term, and twice weekly each was injected subcutaneously with chicken serum. The young consisted of five (litter I) and six (litter II) rabbits. The young rabbits in each of the litters were divided into three groups.

Group *A* were killed and bled the day after they were born.

Group *B* were given post-natal injections of chicken serum before they were four months old (mature). Subcutaneous doses of ½ ml. of antigen were injected three times weekly for four weeks. The rabbits from litter I were first injected four days after they were born. The rabbits from litter II were not given the first injection until they were five weeks old.

Group *C* were given post-natal injections of chicken serum after they were mature. The schedule of injections for this group was the same as given to group *B*.

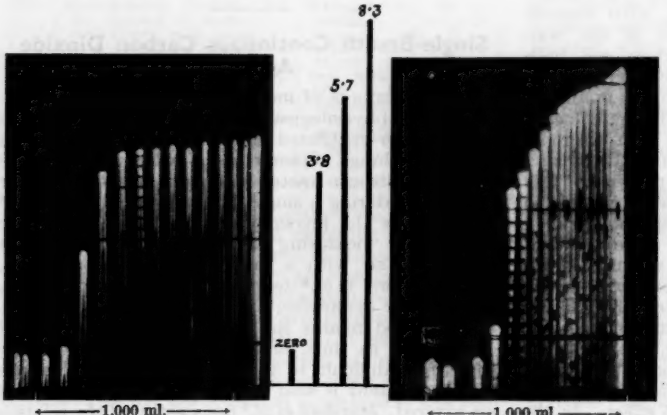

Fig. 1 Fig. 2

Table 1

Litter	Group	Titre	Anaphylaxis
I	*A*	0	none
II	*A*	0	none
II	*A*	0	none
I	*B*	0	none
I	*B*	0	none
II	*B*	1 : 1,500	severe
II	*B*	1 : 2,500	mild
I	*C**	1 : 2,500	fatal
II	*C*	1 : 12,500	fatal
II	*C*	1 : 25,000	not attempted

* One rabbit in this group died before post-natal injections were administered.

All the injected rabbits were bled two weeks after the first injection and again after four weeks. The serum from each blood sample was separated for interfacial 'ring' precipitin tests with dilutions of chicken serum in neutral physiological saline. The antibody activity of the rabbit serum was also tested for ability to induce passive anaphylaxis in guinea pigs. The guinea pigs were injected intravenously with 1 ml. of undiluted young rabbit serum and after 44–48 hr. were challenged with 1 ml. of chicken serum.

The results (Table 1) indicate that, in rabbits exposed pre-natally to chicken serum antigen, antibodies are not present at birth; but, if post-natal injection of antigen is delayed for five weeks after birth, antibodies do form. Burnet[3] has recently reviewed instances in which pre-natal exposure alone was sufficient to inhibit antibody production in mice to lymphocytic choriomeningitis virus and in a human being to *A* and *O* blood groups. The inhibition may be related to the presence of gamma globulins, which have been reported not to appear in the electrophoretic pattern of rabbits until they are six weeks old[1].

When the rabbits of group *B*, litter I, were four months old, they were still incapable of antibody response to repeated injections of chicken serum. When subcutaneous injections of bronze-turkey serum were given, however, the serum of one of the rabbits reacted to a titre of 1 : 2,500 and the serum of the other to a titre of 1 : 100 with dilutions of turkey serum in physiological saline. In precipitin tests with normal antisera produced in rabbits, turkey and chicken serum antigens show strong cross-reactions; but no cross-reaction was observed when the antiserum produced with turkey serum in the pre- and post-natally injected rabbits was tested with chicken serum.

These findings suggest that antisera produced by this method may be of considerable use in specific detection of avian bloods by the precipitin test. Adaptation of the method to the serological detection of bird bloods in hæmatophagous insects is being studied.

I thank Prof. A. S. West, professor of zoology in Queen's University, Kingston, Ontario, for helpful suggestions, and Dr. J. McLintock, Entomology Division, Ontario, for advice during preparation of the manuscript.

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Mucins in the Epithelium of Renal Collecting Tubules

As an incidental finding to a study of the staining of elastic tissue carried out by one of us[1], the luminal borders of the epithelium of the collecting tubule in the kidney of the guinea pig were observed to stain intensely by Gomori's aldehyde–fuchsin method[2] (Fig. 1). We have been unable to find in the literature any previous report of selective staining of the collecting system in the mammalian kidney.

Attempts have been made to interpret the significance of aldehyde–fuchsin staining[2], but little is known yet about its specificity or mode of action. Various other stains were therefore applied to characterize the reacting material. The same sites were demonstrated by a number of methods frequently used to stain mucins (Table 1), and the material is therefore presumed to be related to this general group. Krause[4] has noted the presence of mucins in the collecting system of the dove (*Columba livia domestica*) and lizard (*Lacerta agilis*).

To assess species distribution, kidneys of man, monkey (*Macaca mulatta*), dog, cat, pig, rabbit, rat, mouse, hamster, squirrel (*Sciurus carolinensis*), opossum (*Didelphis virginiana*), chicken, turtle (*Terrapine carolina*), frog (*Rana catesbiana*), toad (*Bufo marinus*), salamander (*Amblystoma maculatum*), goldfish (*Carassius auratus*), and toadfish (*Opsanus tau*) were examined. Materials stained by these various methods (Table 1) have been observed throughout the collecting tubules of the chicken

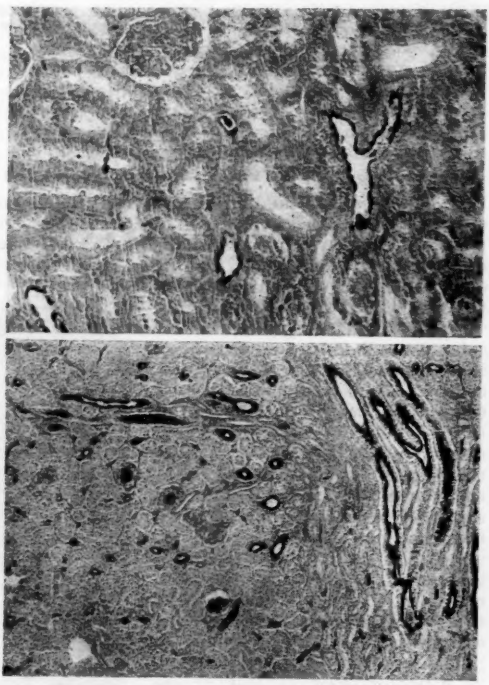

Fig. 1 (*Above*). Terminal ramifications of the collecting ducts in the kidney cortex of guinea pig. Aldehyde–fuchsin staining. × 150

Fig. 2 (*Below*). Arborization of collecting ducts in lobular papilla of kidney in chicken and dispersion into lobule proper. Hale reaction. × 70

Table 1. Staining Properties of the Mucins of Collecting Tubules

	Guinea pig	Chicken	Turtle	Goldfish	Toadfish
Aldehyde–fuchsin	4+	4+	–	2+	—
Hale	4+	4+	4+	4+	4+
Periodic–Schiff	±	2+	2+	3+	2+
Mucicarmine	1+	1+	±	1+	–
Mucihæmatin	1+	1+	1+	1+	–
Metachromasia (thionin)	±	±	–	–	–

(Fig. 2), turtle and toadfish ; and in goldfish, numbers of mucous goblet cells have been found in some of the larger ducts.

The occurrence of such materials in the fish–reptile–bird sequence agrees with Krause's experience and is not remarkable ; but the case of the guinea pig remains a phyletic curiosity. It is of interest to note also that, despite their homologous origins, the collecting tubule mucin of each of these species is histochemically distinct.

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A *Glossopteris* bearing Sori-like Structures

It had been indicated by Feistmantel[1] that some species of *Glossopteris* bear sori in one of the following patterns, namely, in longitudinal rows (Indian materials), along the veins (Australian materials) and along the margin (Indian materials). Unfortunately, these structures were not well recognized in the subsequent literature on fructifications assigned to *Glossopteris*. Recently, an undetermined species of *Glossopteris*, bearing sori-like bodies (Fig. 1) as described by Feistmantel[1,2], has been collected from the Middle Permian (Barakar) in the Central Province of India. The specific determination of the specimen was not possible because its upper half only is preserved and the venation (excepting the midrib) is not always distinct. The rock bearing the fossil is a piece of soft greyish shale.

The sori-like bodies (1·2–2 mm. in diameter, Figs. 1 and 2) are usually round, slightly thickened spots, sometimes oval, and often coalesced and compressed laterally into irregularly linear structures along the margin of the frond. A number of individually recognizable sori-like structures are also present on the margin. These sori-like spots are mostly concentrated on the upper portion of the fossil, the lowermost portion being almost sterile. The supposedly fertile bodies are arranged (1) more or less along the main diverging lateral veins, and (2) also along the margin of the frond. They are not usually equidistant from one another. Those near the margin of the frond are bigger than those near the midrib. A few of them were examined, but unfortunately they did not yield any spore or spore case.

It is very striking that in the present specimen the arrangement of sori-like bodies follows two distinct patterns of distribution (both along the veins and the margin), which have not been found hitherto to occur in the same frond or fronds belonging to the same species[2] as in the present case. So there are at least four types of sorus arrangement in the genus *Glossopteris*, including the three types previously described by Feistmantel[1,2], "which by analogy with living ferns would represent as many different genera, belonging even to quite different families"[1]. The fern-like arrangement of the sori(-like bodies) on the *Glossopteris* fronds as described in this communication and by Feistmantel[1,2] is undoubtedly one of the most primitive types so far known among the seed plants. Feistmantel[1,2] suggested the need for a generic separation of *Glossopteris*, and I formed the same opinion when describing[3] several types of isolated cutinized microsporangia (from macerated Indian Lower Gondwana coal) referable to *Glossopteris*. These microsporangia are of different shapes and sizes, and there may be at least two types of dehiscing mechanism. It is, however, premature to suggest any generic separation of the *Glossopteris* unless more data are available.

Whether the sori-like bodies described by Feistmantel[1,2] and by me here, and the isolated microsporangia previously described by me[3], are the same structures has yet to be established. However, the size and shape of the latter indicate that they can be accommodated in the sori-like structures described in this communication.

The manner in which the sori-like structures are borne on the *Glossopteris* frond indicates that the

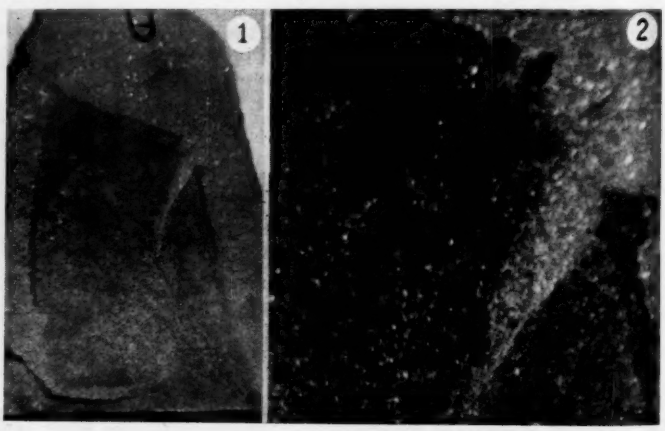

Fig. 1. *Glossopteris* frond showing sori-like structures along the margin and also more or less along the main lateral veins diverging from the midrib. Less than ½ nat. size
Fig. 2. Part of the *Glossopteris* frond showing magnified view of solitary and coalescent sori-like structures. × 3

genus probably belongs to the primitive Pteridosperms, and should be regarded as closely related to the ferns. But on the basis of the new interpretation[4] of the recently discovered ovulate organs of *Glossopteris*, it has been suggested that the genus belongs to an unknown or imperfectly known Gymnosperm rather than to the Pteridosperms. A discussion of the problem will be published elsewhere.

I am indebted to Mr. S. K. Ghosh, geologist in the Sohagpur coalfield, for the material, and to Mr. S. C. Bhattacharya, of the Zoology Department of this University, for photographing it.

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Significance of the Subdermal Space in Pelagic Fish Embryos and Larvæ

Fish eggs can be divided into two main groups, demersal and pelagic, according to their buoyancy. Most freshwater and some marine eggs fall into the first category; truly pelagic eggs, on the other hand, are mainly marine. Certain freshwater fish, the 'bubble blowers', contrive to float off their eggs with an extrinsic mechanism; the egg itself is denser than water.

Between pelagic and demersal fish embryos there is a noticeable and consistent difference in the size of the marginal fin during early life (Fig. 1). The large fin of the pelagic embryo is formed late in egg development by the separation of the thin integument from the underlying mesoderm of the larval axis. There are no supporting structures in the walls of the fin, which must therefore be extended, in life, by turgor within the lumen. The lumen is a subdermal space, filled according to McIntosh and Prince, with "a jelly-like lymph"[1].

The development of voluminous subdermal spaces in fish embryos is clearly related to the pelagic habit. The immature egg of the plaice sinks in sea water. At maturation within the ovary, the egg is distended by a gross intake of ovarian fluid which dissolves the yolk spherules and gives the egg its buoyancy. The ionic composition of this yolk diluent resembles that of adult blood, as indicated by the observations of Milroy[2] and Dakin[3]. It follows that a pelagic marine egg, like the parent, is in constant danger of desiccation under the osmotic gradient; loss of buoyancy is a sure sign of unhealthiness.

If McIntosh and others were correct in describing the egg capsule as porous and freely permeable to salts and water, then osmotic work must be done by the integument of the embryo to prevent an increase in body chloride and a decrease in water content. If enough water is lost, the egg will sink, irrespective of whether it has an oil globule or not. It is a fact that healthy plaice and cod eggs remain buoyant throughout embryonic life in aquaria, even though their degree of reserve buoyancy is not excessive. In 1954, for example, a batch of floating plaice eggs, fertilized in 35 parts per mille sea water, were not buoyant in 32 parts per mille sea water.

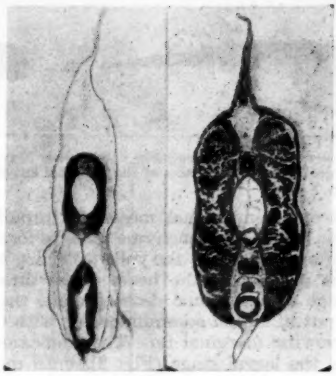

Fig. 1. Transverse sections through the trunk of a 2-day old pelagic plaice larva, × 55 (left), and a 4-day old demersal trout larva, × 30 (right), to indicate a major difference in the extent of the subdermal space

There is no known mechanism for water acceptance by the plaice embryo, from the time of liberation to the point when the mouth and anus open at hatching. One can assume, therefore, that sufficient water to preserve buoyancy must be retained within the embryo; in other words, the overall volume enclosed by the embryonal integument can only decrease within the limit laid down by the initial reserve buoyancy. As soluble nutrients from the fluid yolk are used in tissue synthesis and respiration, the remaining yolk diluent accumulates beneath the integument, separates it from the compact axial structures, and thus forms the subdermal space. The problem of water conservation does not arise in a demersal freshwater fish embryo. One can therefore readily understand the lack of subdermal space in this group and, hence, the ill-developed marginal fin.

The lumen of the marginal fin is not the only subintegumental space in the pelagic embryo and larva. It is not generally known that pelagic marine eggs, unlike demersal freshwater forms, have no circulatory system of capillaries around the yolk. These capillaries develop in the extra-embryonal mesoderm between the periblast layer of the yolk-sac proper and the extra-embryonal ectoderm. Meek[4] observed, during gastrulation in the pelagic egg of the cod,

Fig. 2. Transverse section through the anterior yolk-sac region of a cod larva, × 60, to demonstrate the gross separation of the integument from the underlying tissue, and the continuity of the dorsal marginal fin lumen with the yolk-sac sinus

Fig. 3. Newly hatched plaice larvæ, × 7, with heavy coagulation of plasma proteins in the dorsal and ventral spaces of the marginal fin, after fixation in Heidenhain's Susa

that the extra-embryonal mesoderm rapidly breaks down into isolated mesenchyme cells, to form another sub-integumental space, the yolk-sac sinus, into which the sinus venosus of the heart opens directly. At some stage in embryonic development, the yolk-sac sinus is put in lateral communication with the lumen of the growing marginal fin. The connexion persists well into the larval stage (Fig. 2), until most of the yolk is lost. Nutrient yolk derivatives thus have easy access to embryonic and larval tissues via the subdermal spaces (Fig. 3).

There is therefore, in pelagic fish eggs and larvæ, an unorthodox extension of the primary method of direct yolk appropriation, independent of a blood vascular system. This is, undoubtedly, a result of the formation of subdermal spaces, dictated by the requirements of buoyancy and water conservation. A full account of this work will shortly be published elsewhere.

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Preparation of Cell Suspensions from Plant Roots for Cytological Studies

A considerable amount of microscope work involved in cytological studies of plant roots can be obviated by the preparation of a cell suspension from a number of roots; the cell suspension can then be examined instead of a large number of sections or squashes of individual roots. This is of particular advantage in studies in which the examination of a large cell population is required for the evaluation of the cytological effects of a particular experimental treatment, such as X-radiation. A number of techniques have been described for making cell suspensions from plant roots[1–3], all of which either produce a large number of broken cells or require the use of enzymes. The following simplified method without the use of enzymes has given satisfactory results with *Vicia faba* root-tips, the number of cells broken being negligible.

The root tips are fixed overnight in a mixture of acetic acid and ethanol (1 : 3 v/v), washed for one hour in several changes of tap water and distilled water, and hydrolysed in *N* hydrochloric acid at 60–63° C. for ten minutes. This hydrolysis softens the intercellular matrix sufficiently to allow the subsequent mechanical separation of the cells; it also serves as the essential preliminary step for staining the nuclei by Feulgen's method. The temperature used in this procedure, slightly higher than is usually employed in the Feulgen technique (60° C.), does not impair the staining of nuclei as judged by eye with the microscope. After hydrolysis the roots are stained by the usual Feulgen procedure. The tips are then transferred to 45 per cent acetic acid (1 ml. acid/10 roots) and broken up into a cell suspension by being drawn into and out of a 5-ml. syringe through a serum needle (gauge 0·8 mm.). After three minutes of such treatment, 70 per cent of the cells are in groups of 1–4 cells, 80 per cent in groups of 1–8 cells. The number of broken cells, shown by free nuclei and empty cell walls, is less than 4 per cent. Maceration even for a further two minutes does not increase the number of broken cells.

Groups of beans macerated by this method give the same value for the number of cells per root tip as

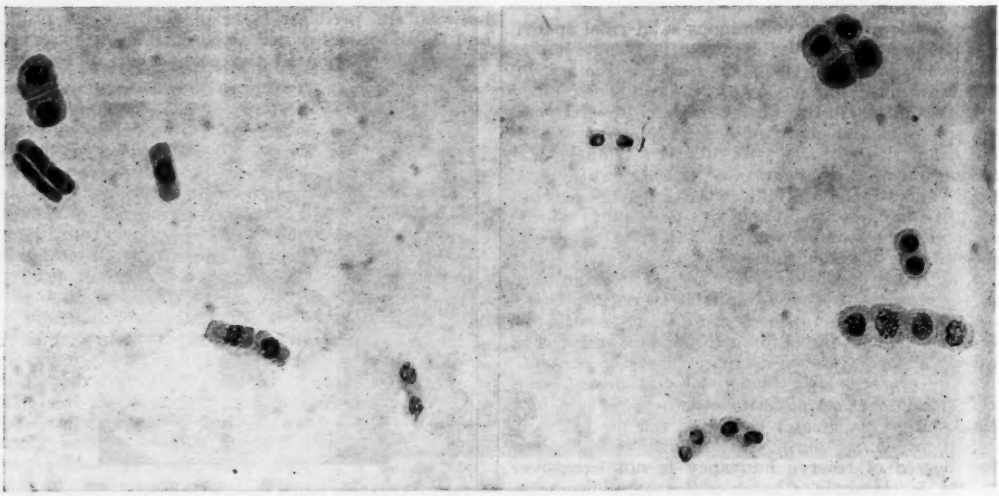

Fig. 1. Meristematic cells of *Vicia faba* roots macerated by the method described, stained by Feulgen's method and counter-stained with light green (× 160)

when they are macerated by the chromic acid technique of Brown and Richless[4]. Maceration is not so complete in the fully differentiated region of the root as it is in the meristem, because in that region, particularly in the case of epidermal cells, the root tends to break into sheets of cells.

The technique has been used successfully in studies of cytological abnormalities caused by X-irradiation of *Vicia faba* roots, the results of which will be reported elsewhere.

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Stoichiometry of Inclusion Compounds

A RECENT study[1] of the formation of a variety of inclusion compounds by potassium benzene sulphonate led to the conclusion that it could form zeolitic structures in the interstices of which various species could be intercalated. Such structures would give Langmuir-type intercalation isotherms[2,3], but the whole isotherm course would not necessarily be realizable because, when the content of included molecules fell below a certain limit, the zeolitic structure may become metastable and collapse into a sorbate-free but more compact crystal lattice of potassium benzene sulphonate.

While most aspects of the behaviour could be explained in terms of the above view, and of current treatments of nucleation and crystal growth, one feature remained not fully accounted for. All the inclusion compounds were formed by bathing crystals of outgassed potassium benzene sulphonate in vapours of various organic species. Usually, at a critical relative pressure, nucleation of crystal growth of the inclusion compound occurred, and reaction rapidly went to completion at this pressure. Thereafter further increases in pressure produced little or no further change in the content of the intercalated species. Moreover, the amount of the intercalated species was often very sensitive to the temperature, but non-stoichiometric in quantity (Fig. 1). We will

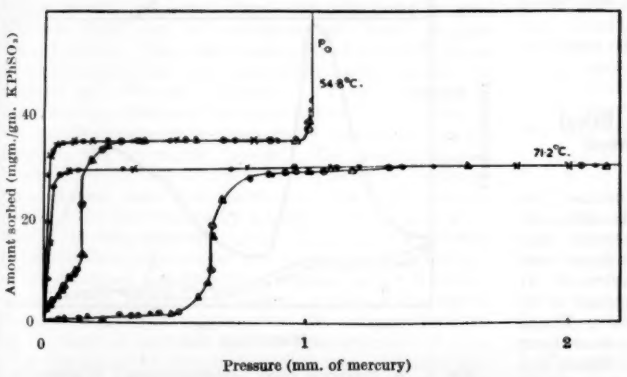

Fig. 1. Sorption isotherms for naphthalene in potassium benzene sulphonate: ⊙—⊙—, first sorption; ●—●—, first desorption; △—△—, second sorption; ×—×—, second desorption

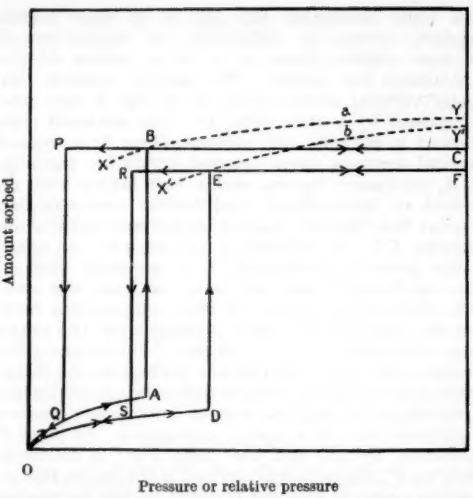

Fig. 2. Expected course of isotherms for the formation of clathrate-type inclusion compounds at temperatures T_1 and T_2 (full lines), compared with true equilibrium course (dotted lines)

consider these pressure-independent, temperature-sensitive, non-stoichiometric phases.

We may call the open lattice of the framework-forming constituent in the complex the 'host lattice'. We need for our purpose to distinguish at least two categories of inclusion compound: (1) in one group the host lattice is stable whether or not it contains included molecules (for example, tectosilicates such as certain of the crystalline zeolites); (2) in a second group the host lattice becomes metastable when the included molecules are at too low a concentration, and tends to collapse into a new phase, as with urea-hydrocarbon adducts, quinol clathrates, and complexes formed by potassium benzene sulphonate.

In both classes of inclusion compound, the true equilibrium content of intercalated molecules varies continuously with the ambient concentration of these[2,3], so that the phases are in general non-stoichiometric over the observable ranges of formation (Fig. 2, curves *a* and *b*). In the second group of inclusion compounds, however, the included molecules may be, and often are, quite immobile. Once the compound has formed, their number cannot then be increased or decreased, because the interstices containing included molecules have no exits wide enough. This circumstance will explain as follows the situation referred to earlier in connexion with the inclusion complexes of potassium benzene sulphonate.

In Fig. 2, XY, $X'Y'$ represent the only parts of the true equilibrium occlusion isotherms of an intercalated species at temperatures T_1 and T_2 respectively ($T_1 < T_2$), which are at least theoretically realizable without instability of the host lattice. When outgassed potassium benzene sulphonate is bathed in vapour of, say, naphthalene, the inclusion complex cannot form until the pressure at T_1 exceeds the value corresponding to the point X. Even here it will not normally

form until nucleation has set in at some higher pressure, owing to difficulties in nucleation of the new zeolitic phase on or in a matrix of the naphthalene-free phase. For similar reasons, the ideally vertical section such as in Fig. 2 may also be replaced by a curve (Fig. 1)[1]. The isotherm path followed is initially *OA*, corresponding to a limited physical sorption upon external crystallite surfaces. At *A*, nucleation occurs, and a host lattice with an amount of intercalated naphthalene corresponding to point *B* is formed—a point on the true equilibrium isotherm *XY*. At *B* reaction is complete. As noted in the previous paragraph, it is assumed that no more naphthalene can now enter or leave the complex, which thus remains of fixed composition however the pressure afterwards changes over the entire range of existence of the complex. On lowering the pressure, the range of existence persists to the metastable point *P* again owing to difficulties in nucleation of crystals of the original outgassed potassium benzene sulphonate on or in a matrix of complex. At point *P* nucleation occurs, and the path *PQO* is followed. Thus, at T_1 the isotherm realized is *OABC* on the increasing pressure run and *CBPQO* on the decreasing pressure run.

At temperature T_2 ($> T_1$) exactly similar considerations apply and the isotherm realized is *ODEF* with increasing pressures and *FERSO* with decreasing pressures. Clearly, then, *PBC* and *REF* represent two non-stoichiometric phases, metastable except at *B* and *E* respectively, of composition independent (within the existence limits) of pressure, but for normal isotherms *XY*, *X'Y'*, sensitive to temperature. This behaviour was observed with the benzene, toluene, *o*-, *m*-, and *p*-xylene and naphthalene inclusion complexes in which potassium benzene sulphonate formed the host lattice[1].

In the paper[1] referred to, not all the results fall into the above pattern. X-ray data indicated more than one crystallographic structure among the complexes, and sometimes Langmuir isotherms were indeed realized, apparently without hysteresis (for example, ethanol, pyridine and ethylamine complexes).

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[1] Barrer, R. M., Drake, J., and Whittam, T. V., *Proc. Roy. Soc.*, A 219, 32 (1953).
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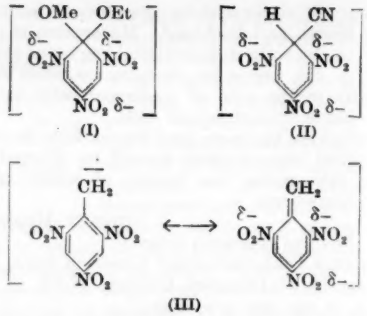
Visible Spectrum of Potassium Ethyl 1-Methoxypicrate and of Related Compounds

The structure of the product obtained by Meisenheimer[1] from potassium methoxide and *s*-trinitroanisole and from potassium ethoxide and *s*-trinitrophenetole which depended on these two products being identical has been confirmed by infra-red spectroscopy[2]. The product appears to be the ion (I). The visible spectra of the products obtained from these two reactions have now been measured. The spectra are identical. There are three maxima in the region 390–600 mμ, namely, at 420 mμ ($\varepsilon = 27{,}000$); at 478 mμ ($\varepsilon = 16{,}500$); and at 494 mμ ($\varepsilon = 17{,}000$).



Hantzsch and Kissel[3] obtained a solid from the interaction of a concentrated aqueous solution of potassium cyanide and a concentrated alcoholic solution of *s*-trinitrobenzene. To this solid Meisenheimer[1] assigned a structure corresponding in more modern terms to (II). This solid has been re-prepared and its spectrum in acetone has been found to be featureless; in no way does it correspond to the spectrum of (I). *s*-Trinitrobenzene gives a red colour with potassium cyanide in damp acetone solution, and in ethyl alcohol solution. The spectrum of this mixture in the region 390–600 mμ is very similar to that of potassium ethyl 1-methoxypicrate (I). This suggests that with *s*-trinitrobenzene and potassium cyanide a compound of structure (II) is at first formed in solution. Solutions are stable for at least 48 hr., if kept away from light. However, when exposed to light, the spectrum changes to a featureless spectrum more closely resembling the spectrum of

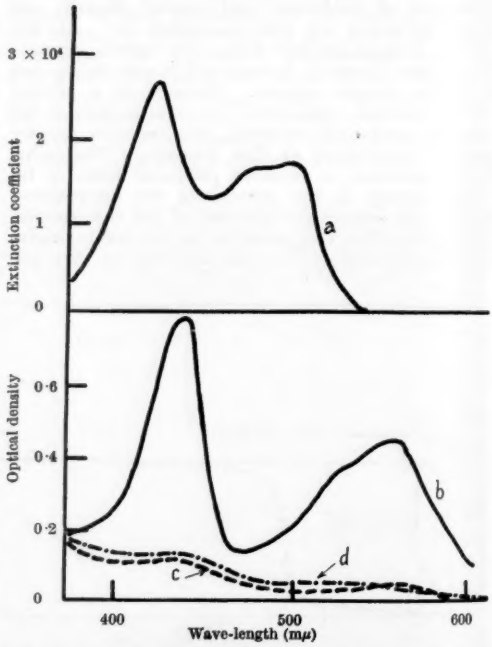


Fig. 1. *a*, Potassium ethyl 1-methoxypicrate; *b*, potassium cyanide and *s*-trinitrobenzene immediately after mixing; *c*, potassium cyanide and *s*-trinitrobenzene after 7 min. exposure to diffuse daylight; *d*, product obtained by Hantzsch and Kissel (all solutions are in acetone)

the solid product obtained by Hantzsch and Kissel. Compound (II) may therefore have a more transient existence than has hitherto been supposed. Similar spectra are obtained in ethyl alcohol solution. This eliminates the possibility that an acetone molecule is involved in the complex ion, as is thought to be the case in some *m*-dinitrobenzene complexes[4].

It is interesting to note in this connexion that the spectrum of potassium ethyl 1-methoxypicrate does not resemble the spectra of either the product of interaction of *s*-trinitrobenzene and potassium ethoxide (or methoxide) or of *s*-trinitrotoluene and potassium ethoxide (or methoxide); neither do the spectra of these two latter products closely resemble one another. It has been suggested that in the case of *s*-trinitrotoluene + methoxide the product is an ion of the type (III)[5]. The fact that the spectrum of this product has a maximum at 370 mμ which is close to that of the picrate ion (356 mμ) may be further evidence in support of structure (III) in this case, as the ion (III) is *iso*-electronic with the picrate ion.

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[1] Meisenheimer, J., *Annalen*, **323**, 205 (1902).
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The Solid - Liquid Equilibrium Diagram of Argon and Krypton

Measurements of the properties of condensed solutions of the inert gases should prove important in the development of the theory of solutions because of the comparatively simple nature of the interatomic forces. While, from the theoretical point of view, equilibrium diagrams are complicated in that they necessarily contain information concerning two or more forms of solution, their determination is a most useful initial step in the examination of any system.

Argon and krypton were chosen for the present investigation because they are inexpensive and because they can be condensed at liquid oxygen temperatures. The solid – liquid equilibrium diagram of this system has been previously measured by the method of thermal analysis[1]. Time/temperature curves were obtained for five different mixtures of known composition as they were heated or cooled through the transition points. The discontinuities in the slopes of these curves did not occur at a definite temperature, and the melting points and freezing points were determined by a method of extrapolation which, it was claimed, gave an accuracy in the transition temperature of 0·1 deg. The composition of the mixtures was known to approximately 0·05 per cent. These results are shown in Fig. 1, in which the mole fraction of krypton (x) of solutions in equilibrium is plotted against temperature.

In the present investigation this same method was tried; but it proved unsatisfactory because of the difficulty of locating the melting point for any composition and the freezing point for mixtures of about

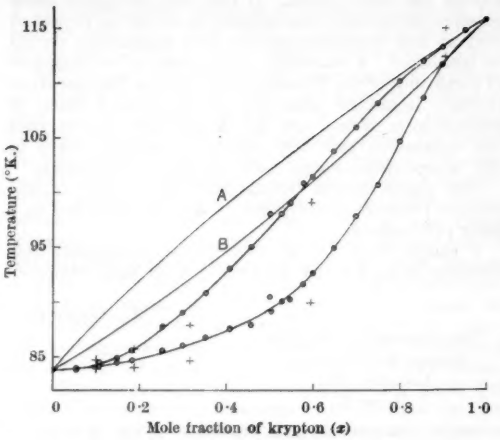

Fig. 1. Equilibrium diagram of argon and krypton: *A* and *B*, ideal solutions; +, Veith and Schröder (ref. 1); ○—○—, present investigation

equimolar proportions. To overcome this difficulty a new method has been developed. The total vapour pressure (P) of mixtures of known composition has been measured as a function of temperature (T). Graphs of $\log P / \left(\frac{1}{T}\right)$ have been drawn and although the discontinuities in slope are not 'sharp', a small extrapolation of one straight or nearly straight line enables each transition point to be determined. The results of measurements of twenty-two different mixtures are shown in Fig. 1. Temperature was measured with a copper–constantan thermocouple with an accuracy of 0·1 deg. K. and the compositions were determined to 0·5–1 per cent. Both gases were obtained commercially. The purity of the argon was such that the temperature range of melting was not more than 0·05 deg. The krypton contained 0·5 per cent xenon, which was also the case in the earlier determination[1].

Fig. 1 shows that argon and krypton are soluble in all proportions in the solid and liquid states. The equilibrium diagram that would result if both solutions were ideal is drawn on the figure. It may be seen that when x approaches 1 the measured solidus and liquidus approximate to those of the ideal solutions. For all other values of x the concentration of krypton in both solid and liquid solutions in equilibrium exceeds that in the ideal solutions at the same temperature. A preliminary examination of the vapour-pressure measurements indicates that, for $x \simeq \frac{1}{2}$, $\frac{P}{P_i}$ (where P_i is the total vapour pressure of the ideal solution) for the solid solution at the melting point is greater than for the liquid solution at the freezing point. In both cases P/P_i is greater than 1. These facts suggest that for $x \simeq \frac{1}{2}$ the deviations from ideality in the solid are more positive than in the liquid solution, and that both solutions exhibit positive deviations.

The measurements have extended down to about 62° K. for argon-rich mixtures and to 70° K. for krypton-rich mixtures, and no evidence of any phase change between these temperatures and that of the

solidus has been found. If the solid solutions show positive deviations from ideality, it would be expected that at low temperatures the two substances would be insoluble. A calculation (reported in an account[2] of a meeting of the Physical Society Low Temperature Group), assuming that the intermolecular force of attraction is of the van der Waals type, shows that the separation into two phases would not occur in the temperature-range used in this investigation.

The experimental details and the results of the vapour pressure measurements will be discussed in a later publication.

I thank Prof. G. O. Jones, who suggested this investigation, for his continued help and advice.

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[1] Veith, H., and Schröder, E., *Z. phys. Chem.*, A, 179, 16 (1937).
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Serially Balanced Sequences

Williams[1] has devised experimental designs for use when several subjects are to be tested on successive occasions, and the response to the treatments on any one occasion may be modified by residual influences of the one or two previous treatments. We have recently considered the possibility of analogous designs that, under certain assumptions about the mathematical model, could be used for an experimental comparison of treatments on many occasions with one subject only. The practical importance of these designs is probably not great, but they are of interest as introducing new combinatorial problems.

Suppose that four treatments are represented by the letters A, B, C, D. Consider the sequence

$$A\,;\ B, C, A, D\,;\ A, C, B, D\,;\ C, D, B, A.$$

This is an example of a serially balanced sequence for four treatments. More generally, for t treatments, a serially balanced sequence is defined as follows: (i) each treatment follows each other treatment once (hence the whole sequence has $(t^2 - t + 1)$ members, one letter being repeated t times and the others $(t - 1)$ times each); (ii) after the first treatment, each block of t successive treatments contains one complete replicate. The first and last treatments must be the same. From any sequence, $(t - 2)$ new ones can be generated by cyclic permutation of whole blocks of four and alteration of the first letter to the new last letter. From each of these, a further $(t - 1)$ can be generated by discarding the first letter, reversing the order of the remaining $t(t - 1)$, and inserting a new first letter. For $t = 4$, sequences can be classified into three transformation sets, all members of a set being related by block permutation, reversal and letter permutation.

Statistical analysis according to the standard additive model is practicable if the time trend can be adequately represented by $(t - 2)$ parameters for differences between the $(t - 1)$ blocks; the first treatment is regarded purely as a conditioning of the subject, and no use is made of observations on it. The immediate effects of treatments and their residuals at the time of the next treatment each require $(t - 1)$ parameters, leaving $(t - 1)(t - 3)$ degrees of freedom for the estimation of the error variance. If a longer experiment is required, so as to increase replication and to improve the estimate of error, two or more sequences can be used consecutively provided that all begin with the same letter: for each one after the first, this initial letter is telescoped with the last letter of the previous sequence.

Despite the balance, non-orthogonality makes the analysis awkward. For some values of t (but not for $t = 4$), additional balance can be achieved by having each block also contain one residual from each treatment. For example, with $t = 5$, the sequence

$$A\,;\ B, D, E, C, A\,;\ E, B, C, D, A\,;\ C, E, D, B, A\,;\ D, C, B, E, A$$

is such that both the first $t(t - 1)$ and the last $t(t - 1)$ letters form $(t - 1)$ successive replicates.

For most experimental purposes, a more complete form of serial balance, in which every letter follows every letter including itself once, and which therefore requires a sequence of $(t^2 + 1)$ letters, is obviously preferable. However, such sequences appear to be much rarer. None exists for $t = 3, 4, 5$; for $t = 6$ there are plenty, one such being

$$A\,;\ A, B, C, D, E, F\,;\ F, C, E, A, D, B\,;\ B, A, F, E, D, C\,;\ C, A, E, B, F, D\,;\ D, F, A, C, B, E\,;\ E, C, F, B, D, A.$$

Cyclic permutation of blocks and reversal again generate new sequences.

Further study of these sequences is in progress, and a paper describing their application in bioassay is in preparation.

This communication was prepared without knowledge of a paper by R. M. Williams[2] in which analogous designs were discussed; Williams, however, used a less severe constraint by balancing treatments in respect of adjacent treatments on either side instead of the preceding treatment only.

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[1] Williams, E. J., *Australian Journal of Scientific Research*, A, 2, 149 (1949); A, 3, 351 (1950).
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Corrosion and Meteorology

In studies of corrosion under tropical conditions, it has for a long time been the practice to quote average yearly conditions of temperature and humidity. Although laboratory or simulated tropical testing is often carried out under cyclic conditions, these cannot be truly representative of the climatic conditions unless a complete examination of the climatic conditions is first made. This is particularly important in view of the principle of critical humidity developed by Vernon, Hudson, Patterson and Hebbs, and others[1], and also the work of Clarke[2] on fluctuating humidity.

An analysis of the climatic conditions in Singapore during 1953[3] gave the following information on the percentage relative humidity per day during each month:

Month	Hr. per day at each range of relative humidity		
	65–80 per cent	80–90 per cent	More than 90 per cent
January	9	4	11
February	8	5	11
March	8	5	11
April	7	5	12
May	9	6	9
June	9	13	2
July	9	9	4
August	10	11	3
September	9	9	6
October	10	7	7
November	9	6	9
December	9	5	10

From these figures it may be generalized that an 'average' day in Singapore has the following hours of humidity :

65–80 per cent relative humidity, 9 hr./day.
80–90 " " " " 7 "
More than 90 " " " " 8 "

These values bear a general resemblance to the average figures and ranges often quoted for Singapore : average maximum humidity, 95 per cent ; average minimum humidity, 69 per cent ; average humidity, 80 per cent. But these latter figures do not take into account the time of exposure to the maximum and minimum conditions. Time is just as important as the level of humidity in corrosion processes.

From the point of view of the deterioration of paint films on metal surfaces exposed to the direct rays of the sun, the sun temperature is of great importance, and work in Singapore has shown that sun temperatures of 130–150° F. are quite normal. A full investigation of these factors is being carried out and will be published elsewhere.

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[1] Vernon, *Trans. Farad. Soc.*, **23**, 162 (1927) ; **27**, 264 (1931) ; *Trans. Electrochem. Soc.*, **64**, 35 (1933). Hudson, *Trans. Farad. Soc.*, **25**, 205 (1929). Patterson and Hebbs, *Trans. Farad. Soc.*, **27**, 277 (1931). Patterson and Wilkinson, *J. Soc. Chem. Indust.*, **57**, 445 (1938) ; **60**, 42 (1941). Bengough and Whitby, *Trans. Inst. Chem. Eng.*, **11**, 176 (1935).

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I SHOULD like to make two comments on Major P. A. Cartwright's letter printed above.

(1) Major Cartwright is right in stressing the important bearing of climatic conditions on atmospheric corrosion, and his view that the variation in the relative atmospheric humidity throughout the exposure period is much more important than the overall average value will meet with general approval. I am particularly interested in this aspect of the matter and have from time to time published diagrams such as Fig. 1, one of which relates to Singapore.

According to the classical researches of Vernon, the critical humidity for the atmospheric rusting of iron lies somewhere between 70 and 80 per cent relative humidity. In the diagrams I have, therefore, shown the periods of the day, averaged for each month of the year, during which the relative humidity of the atmosphere at the places concerned lies below, between, or above, these limits. We do not know whether or not the critical relative humidity varies with the atmospheric temperature ; but, if we assume a value of 70 per cent everywhere, the diagrams show that the conditions are propitious for rusting at Singapore during no less than 99 per cent of the year ; the corresponding figures for Kew and Pittsburgh are 80 and 49 per cent, respectively. Incidentally, the Pittsburgh figure and corresponding data for other American observatories suggest that on the whole the corrosion hazard due to humidity alone is rather less in the United States than in Great Britain.

(2) It does not follow that serious corrosion will take place whenever the humidity is favourable. As Vernon showed, it is also necessary that the atmosphere should be polluted. The most damaging type of pollution is sulphur in the form of combustion products. Joint investigations by the British Iron and Steel Research Association and the Fuel Research Station have shown that in Great Britain, where the relative humidity does not vary much over the whole country, the corrosion of iron at different sites is directly proportional to the sulphur pollution of the atmosphere. Where the sulphur pollution is inappreciable, the rate of rusting is small. In conformity with this, in earlier tests made at Singapore itself, on mild steel plates freely exposed in the open at Seletar Aerodrome, the average rate of rusting observed was only 0·6 mil (0·0006 in.) per year. This figure is comparable with the rates for rural atmospheres in Great Britain—for example, 1·2 mils per year at Llanwrtyd Wells—and is much smaller than those observed in industrial atmospheres, such as Sheffield, where figures of 4 mils or more per year are not uncommon.

This does not contradict the fact that very severe corrosion may often occur in the tropics. Humid atmospheres heavily charged with salt spray, such as are found on surf beaches, are extremely corrosive, and rates of 40–50 mils per year have been recorded at sites of this type. Although the corrosion-rate falls off rapidly with increasing distance from the sea, heavy condensation may play a decisive part at inland tropical sites, since it is clear that the ease with which condensed moisture evaporates from the metal is very important. It is difficult to reproduce the full effects of this factor in small-scale experiments, and it may well be that, for practical purposes, observations made on actual articles and components will provide a better guide to the severity of the corrosive attack that is to be expected in jungles and similar places.

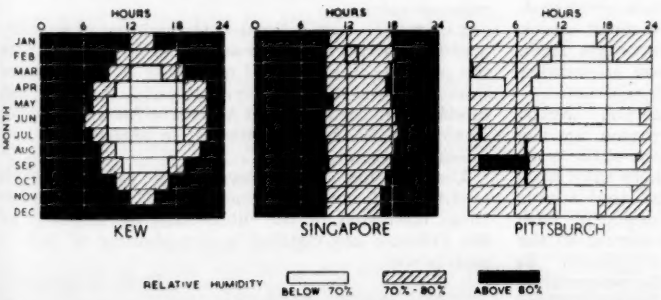

Fig. 1. Variation in the relative humidity at Kew, Singapore and Pittsburgh throughout the day

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Reactivity of Freshly Formed Steel Surfaces

Prince[1] has observed that a freshly sheared steel surface rusts far quicker than would be expected at ordinary temperatures. Whether or not it is always legitimate, in statistically distributed events, to draw conclusions from isolated observations, recorded facts support his statement in the present case. The corrosion probability of a freshly scraped surface is higher than that of a surface exposed to air; statistical studies by Mears[2] have shown that the probability number for rusting at scratch lines traced on iron, and, after exposure to air, covered with 0·07 *M* sodium bicarbonate, declines steadily with the duration of exposure.

Prince tentatively suggests that hydrogen peroxide plays a part in the rusting, apparently by converting ferrous to ferric hydroxide; under ordinary conditions, however, ferrous hydroxide would be oxidized by atmospheric oxygen, and there is no need to postulate hydrogen peroxide as the oxidizing agent. Incidentally, Pietsch and his colleagues[3] showed that the addition of pure (unstabilized) hydrogen peroxide to water prevented or postponed the rusting of homogeneous iron, which occurred rather quickly in water free from peroxide; possibly this passivation might not occur on steel—nor with hydrogen peroxide as found in the reagent bottle.

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[1] Prince, A., *Nature*, **176**, 223 (1955).
[2] Mears, R. B., and Evans, U. R., *Trans. Farad. Soc.*, **31**, 527 (1935).
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An Epidemic of Words

Epidemiology is a fascinating subject. Much the same interest is aroused and the same scientific principles involved whether, with Lodge in 1603, we discuss an "epidemick [of plague] . . . common unto all people or most of them"; or with Morgan in 1728 we discover that the mange is the "epidemical distemper" of the camels of the Algerians; or we realize with Berkeley (1857) that it was an epidemic of Irish blight which sent the Irish to New York and New Holland during the 'forties of the last century; or (more metaphorically as we nowadays think) we may disagree with John Milton (1643) that divorce is a "toleration of epidemick whordom". Thus 'epidemic', soon after the word was coined, came to have a wider and a narrower meaning than the original Greek επιδημος. Epidemiology has apparently retained this wide meaning. It is correct to discuss the epidemiology of myxomatosis in the rabbit, and when we discuss the epidemiology of Irish blight we know we are not discussing a direct attack of *Phytophthora infestans* on the unfortunate Irish, although perhaps there may have been an indirect attack on them by way of the potato murrain.

Epidemics are, of course, dangerous things. Although I could see no scientific reason for the recent re-introduction and popularization of the word 'epizootic' to discuss myxomatosis, there may have been some political reasons. I now find that I have been in error in referring to an epidemic of Irish blight, Hayes and Immer in 1942 referring to the artificial production of epiphytotics on plants. In future, epidemics on plants should be referred to, not as epiphytics (Lindley in 1830 having defined this word correctly and according to the original Greek), but as 'epiphytotics', to rhyme, one supposes, with epizootics, which, of course, except for Todd's pre-emption in 1836, might have been epizoics.

This is a small epidemic of words. Epidemics are infectious diseases. Unless strong antiseptics are used, we may soon find ourselves with a new science of epibiology (or should it be epibioticology ?), with the three subsciences of epidemiology, epizoology (or epizooticology ?) and epiphytology (or epiphytoticology ?).

The related word 'endemic' has travelled a long way in meaning since Stanley's description in 1657 of "Those endemical malignant vapours, which infect the air". Its modern scientific use was carefully defined by Charles Darwin in the first edition of "On the Origin of Species" (1859), when he wrote "in oceanic islands . . ., the proportion of endemic species (i.e. those found nowhere else in the world) is often extremely large". Cannot our epidemiologists define an epidemic to include epidemics on populations of all living organisms, whether man, potato, rabbit or bacterium ?

Since writing the above, I have found that the epidemic of words has already started, Large, in 1940, referring to the new American science of 'epiphytotiology' or the use of meteorology in the prediction of epidemics on plants.

H. N. Barber

University of Tasmania.
July 6.

"Educational Problems of the Colonial Territories"

In the leading article in *Nature* of August 20 on "Educational Problems of the Colonial Territories", it is stated that "only some 450 scientists are at present engaged in Colonial research", and that "any expansion in research must draw largely on the limited supplies of scientific and technical man-power in Britain itself". Most British scientific workers are superannuated at the age of approximately sixty-five. Many of them are capable of another ten years of research, and a moderate amount of teaching. Some, at least, would be happy to work in a Colonial university or research institute. The necessary qualifications are the capacities to work in a tropical or subtropical climate, and to form friendships with non-Europeans.

Many branches of biology and geology, not to mention mathematics, require little expensive apparatus; and a salary less than that of a junior lecturer would be a welcome supplement to a pension. The research carried out would not often be of immediate economic applicability, but it would, I think, be of cultural value.

I may have over-estimated the number of suitably qualified British scientists available, but I think that the presence in a Colonial university of even two or three Fellows of the Royal Society carrying out fundamental research with African or Asian colleagues would help the local population to generate its own scientific culture.

Until it has been proved that elderly British scientists will not accept such offers, I doubt whether those interested in the intellectual development of the Colonies are justified in complaining of lack of man-power.

J. B. S. Haldane

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 17

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5 p.m.—Madame Alva Myrdal: "The Interplay of Factors in the Development Process". (First of five Heath Clark Lectures on "The Role of Health and Education in the Process of Social Development". Further Lectures on October 18, 19, 20 and 21.)*

UNIVERSITY COLLEGE LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. F. Danielli: "Nuclear and Cytoplasmic Sites of Drug Action"*.

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Sir Charles Morris: "The Perennial Appeal of Plato". (First of nine Lectures by various speakers, on "Intellectual Currents and Their Educational Message", to be given on each Monday until December 12.)*

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. F. C. Reid: "Some Experimental and Practical Aspects of Heavy Rhodium Plating".

Tuesday, October 18

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. R. H. Garstang: "Palomar Explores the Universe".*

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. R. Kompfner: "Travelling Wave Tubes" (Duddell Lecture); Dr. J. W. Mitchell: Charles Vernon Boys Lecture.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. C. S. de Whalley: "The Decolorization of Sugar Liquor by Solid Absorbents".

UNIVERSITY OF LONDON (at Senate House, London, W.C.1), at 5.45 p.m.—Prof. S. W. Wooldridge: "Geography and the Physical Sciences". (First of three Lectures on "The Teaching of Geography". Further Lectures on October 19 and 20.)*

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Analogues and Equivalent Circuits".

SCIENTIFIC FILM ASSOCIATION (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Sir Arthur Elton, Bart.—Presidential Address.

Wednesday, October 19

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. J. D. N. Nabarro: "Diabetes and Carbohydrate Metabolism". (Further Lecture on November 2.)*

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 2.45 p.m.—Annual General Meeting. Presidential Address: "The Place of Astronomy in Navigation".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (in the Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1), at 5 p.m.—Discussion on "What Makes an Engineer?" opened by Mr. J. G. Straw.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. W. A. Lewis and Mr. L. H. Watkins: "Investigation into the Accuracy of Four Types of Rainfall Recorder"; Mr. J. S. Turner: "The Salinity of Rainfall as a Function of a Drop Size"; Mr. E. M. Fournier D'Albe, Mr. A. M. A. Lateef, Mr. S. I. Rasool and Mr. I. H. Zaide: "The Cloud-Seeding Trials in the Central Punjab, June–September, 1954".*

BRITISH COAL UTILISATION RESEARCH ASSOCIATION (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Prof. Sir Cyril Hinshelwood, F.R.S.: "The Carbon of Coal" (Fourth Coal Science Lecture).

EUGENICS SOCIETY (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. F. Loutit: "Biological Hazards of Nuclear Fission".*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.45 p.m.—Dr. James V. Neel (Michigan): "The Genetic Control of Haemoglobin Synthesis" (Galton Lecture).*

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. M. V. Wilkes: "Present Status of Digital Computors in Physical Research".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at King's College, Strand, London, W.C.2), at 6.30 p.m.—Prof. H. C. Longuet-Higgins: "Some Recent Advances in Physical Organic Chemistry".

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. L. O. Freeman: 'Particle Size Assessment".

Thursday, October 20

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. H. Chapman: "Research as a Business Enterprise"; Mr. J. F. G. R. Heywood: "Pressure Manifestations at Great Mining Depths on the Witwatersrand".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. E. J. H. Corner, F.R.S.: "Taxonomy and Tropical Plants"; Mr. A. W. Exell: "The Projected Flora Zambesiaca".

UNIVERSITY OF LONDON (in the Metallurgy Lecture Theatre, Imperial College of Science and Technology (Royal School of Mines), London, S.W.7), at 5 p.m.—Dr. R. F. Mehl (Pittsburgh): "Diffusion". (First of four Special University Lectures on "Kinetics and Mechanisms in Metal Systems". Further Lectures on October 21, 24 and 25.)*

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Mr. G. Mackworth-Young: "The Mechanics and Acoustics of Singing".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Junior Institution of Engineers, Pepys House, 14, Rochester Row, London, S.W.1), at 6 p.m.—Dr. S. J. Gregg: "Some Observations on Dead Burning, especially of Lime and Magnesia".

CHEMICAL SOCIETY (in the Lecture Theatre of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 7.30 p.m.—Prof. M. Calvin (University of California): "The Photosynthetic Carbon Cycle" (Centenary Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. R. M. Gordon: "The Host-parasite Relationship in Filariasis" (Presidential Address).

Friday, October 21

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr. R. W. Sperry (California): "Some Neural Mechanisms Underlying Perception".*

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. P. L. Jones: Presidential Address.

ASLIB (at the Library Association, Malet Place, London, W.C.1), at 6 p.m.—Meeting on "The Case for a New Public Technical Library and Information Service". Speaker: Dr. D. J. Urquhart.

Saturday, October 22

BIOCHEMICAL SOCIETY (in the Department of Physiology, Bedford College, Regent's Park, London, N.W.1), at 2 p.m.—Scientific Papers.

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at the Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Dr. K. Lovell: "A Study of the Problems of Intellectual Deterioration in Adolescents and Young Adults".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. K. C. Rosser: "A 'Hermit' Village in the Himalayas".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

MASTER (with a degree or recognized teaching qualification) to teach Mathematics at the General Wingate School, Addis Ababa, Ethiopia—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Wingate School" (October 21).

LECTURER or RESEARCH ASSISTANT IN BACTERIOLOGY AND VIRUS DISEASES—The Registrar, The University, Sheffield (October 22).

SENIOR LECTURER or LECTURER IN CIVIL ENGINEERING and a SENIOR LECTURER or LECTURER IN MECHANICAL ENGINEERING—Registrar, The University, Manchester 13 (October 24).

ELECTRONICS ENGINEER or PHYSICIST (with recognized professional qualifications in electronics, and an interest in computing machines) IN THE COMPUTATIONAL LABORATORY, to work on problems of character recognition in connexion with mechanical translation—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (October 29).

ASSISTANT LECTURER IN PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (October 31).

ASSISTANT LECTURER or LECTURER IN VERTEBRATE ZOOLOGY—The Registrar, King's College, Strand, London, W.C.2 (October 31).

CHAIR OF INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham (October 31).

LECTURER or SENIOR LECTURER IN PURE MATHEMATICS at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

LECTURERS (2) or SENIOR LECTURERS IN PURE MATHEMATICS; LECTURER IN THE SCHOOL OF CHEMISTRY; CHAIR OF MEDICINE, and a SENIOR LECTURER IN PHYSIOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

TUTORIAL STUDENT (graduate) IN BIOCHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (October 31).

MYCOLOGIST (with a first- or second-class honours degree) for research on freshwater fungi at Windermere Laboratory—The Director, Freshwater Biological Association, The Ferry House, Ambleside (November 1).

RESEARCH ASSISTANT (with a degree in physics and preferably some research experience) IN PHYSICS, to undertake measurements of high precision, using a reflecting echelon interferometer—The Registrar, King's College, Newcastle-upon-Tyne (November 1).

SENIOR LECTURER OR LECTURER IN PHILOSOPHY at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 1).

LECTURER or ASSISTANT LECTURER IN ANATOMY—The Registrar, The University, Manchester 13 (November 7).

LECTURER IN GEOGRAPHY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 7).

LECTURER (with special qualifications in inorganic or physical chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Edinburgh (November 7).

CHAIR OF NUCLEAR ENGINEERING at Queen Mary College—Academic Registrar, University of London, Senate House, London, W.C.1 (November 9).

CHAIR OF ZOOLOGY—The Registrar, University College, Singleton Park, Swansea (November 12).

LECTURER or ASSISTANT LECTURER IN GEOGRAPHY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

LECTURER IN THE DEPARTMENT OF EDUCATION at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

SENIOR LECTURER IN PHYSICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 21).

FELLOW, and a SENIOR RESEARCH FELLOW, IN THE DEPARTMENT OF STATISTICS, Australian National University, to undertake research in mathematical statistics or its applications, including mathematical genetics—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 30).

READER IN GEOLOGY—The Registrar, University of Dacca, Ramna, Dacca, East Bengal, Pakistan (November 30).

PROFESSOR OF CHEMICAL ENGINEERING; PROFESSOR OF SOIL MECHANICS, and a PROFESSOR OF PHYSICS—The Dean, Faculty of Engineering, Giza, Egypt (December 1).

GUINNESS RESEARCH FELLOW IN MICROBIOLOGICAL BIOCHEMISTRY—The Administrative Officer, Department of Biochemistry, The University, South Parks Road, Oxford.

LECTURER (graduate of a British University, with industrial experience) IN POWER ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

PHYSICAL CHEMIST, Scientific Officer grade (with a first- or second-class honours degree or equivalent in chemistry, and preferably with research experience in surface chemistry with special reference to wetting of solids by liquids; friction and lubrication; adhesion; capillarity; or related phenomena), at the Ministry of Supply Royal Aircraft Establishment, Farnborough, Hants, for work directed towards the solution of lubrication and fluid problems associated with aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.711/5A.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (preferably with a degree in physics, electrical engineering or electronics or at least H.S.C. in science subjects or equivalent qualifications) IN THE GENERAL PHYSICS DIVISION, to assist in the experimental work and maintenance of the cyclotron, and in the design, construction and maintenance of the auxiliary apparatus—The Establishment Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/410.

SENIOR RESEARCH ASSISTANTS (with a good honours degree in engineering, practical experience and/or research training) in the Departments of Civil and Mechanical Engineering, for work in the fields of photo-elasticity, fatigue of metals and the creep and deformation of metals at high temperatures—The Registrar, The University, Nottingham.

TECHNICAL AUTHOR (with a first- or second-class honours degree in either chemistry, engineering or physics and with appropriate experience, and preferably with knowledge of the technical aspects of atomic energy) IN THE PUBLIC RELATIONS BRANCH, for duties which include the preparation in non-technical or semi-technical terms for general or limited publication of news items, booklets and exhibition scripts on technical and scientific subjects—United Kingdom Atomic Energy Authority, E.1B, 14 Ormond Yard, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Rowett Research Institute. Collected Papers: Summary and Subject Reviews. Vol. 11. Pp. iv+44+76 papers. (Bucksburn: Rowett Research Institute, 1955.) [67

Empire Cotton Growing Corporation. Annual Report for the year ending 31st March, 1955. Pp. ii+26. (London: Empire Cotton Growing Corporation, 1955.) [67

British Steel Castings Research Association. Second Annual Report, 1955. Pp. ii+30. (Sheffield: British Steel Castings Research Association, 1955.) [127

British Rubber Development Board. Annual Report for 1954. Pp. 47. Rubber Technical Developments Limited. Annual Report for 1954. Pp. 15. (London: British Rubber Development Board, 1955.) [127

Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory. Pp. 33. (Herstmonceux: Royal Greenwich Observatory, 1955.) [127

Inter-University Council for Higher Education Overseas, 1946–1954. Pp. iv+41+4 plates. (Cmd. 9155.) (London: H.M. Stationery Office, 1955.) 2*s.* 6*d.* net. [127

Building Research Digest. No. 78 (June, 1955): Vibrations in Buildings. Pp. 7. (London: H.M. Stationery Office. 1955.) 3*d.* [157

London and Home Counties Regional Advisory Council for Higher Technological Education. Bulletin of Special Courses in Higher Technology (including Management Studies and Commerce), 1955–56. Part 1—Autumn Term 1955. Pp. ii+70. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1955.) 1*s.* 6*d.* [157

Institute of Personnel Management. Occasional Paper No. 7: Revising a Merit-Rating Scheme. By A. G. F. Elliot. Pp. 23. (London: Institute of Personnel Management, 1955.) 3*s.* [157

Air Ministry: Meteorological Office. Professional Notes. No. 113: Depressions Crossing Labrador and the St. Lawrence Basin. By Dr. A. G. Forsdyke. Pp. 44. (M.O. 524m.) (London: H.M. Stationery Office, 1955.) 1*s.* 6*d.* net. [157

Department of Scientific and Industrial Research. Building Research Station. Analysis of Symmetric Cylindrical Shells: Its Application to Civil Engineering Design. By Dr. John McNamee. Pp. v+85. (London: H.M. Stationery Office, 1955.) 12*s.* 6*d.* net. [157

Other Countries

Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture (I.R.S.I.A.). Rapport Annuel, Exercice 1954. Pp. 205. (Bruxelles: Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture, 1955.) [127

New Zealand Forest Service. Forest Research Institute. Technical Paper No. 4 (January 1955): Comparative Tests with Wood Preservatives. By D. R. Carr. Pp. 48+8 plates. New Zealand Forestry Research Notes. No. 1 (January 1955): Combined Taper and Volume Tables for *Pinus radiata*—Auckland, 1952: Unthinned Stands; *Pinus radiata*—Nelson, 1952: Unthinned Stands; *Pinus radiata*—Canterbury, 1952: Unthinned Stands; *Pinus radiata*—Southland, 1952: Thinned Stands. By G. Duff and S. W. Burstall. Pp. 72. (Wellington: Government Printer, 1955.) [127

Det Kongelige Industri-, Håndverk- og Skipsfartsdepartement. Norsk Polarinstitutt. Skrifter Nr. 107: Stratigraphy of the Marine Late-Pleistocene of Billefjorden, Vestspitsbergen. By Rolf W. Feyling-Hanssen. Pp. 186+27 plates. (Oslo: Brøggers Boktrykkeris Forlag, 1955.) 22 kronor. [127

Deutsche Akademie der Wissenschaften zu Berlin. Veröffentlichung des Geodätischen Institutes in Potsdam. Seismometrische Beobachtungen in Potsdam, 1939–1948. Pp. 110. Seismometrische Beobachtungen in Potsdam, 1951. Pp. 19. Seismometrische Beobachtungen in Potsdam, 1952. Pp. 23. (Berlin: Akademie-Verlag, 1952–1954.) [127

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National de la Kagera—Mission J. Lebrun (1937–1938). Fascicule 2: Esquisse de la Végétation du Parc National de la Kagera. Par Jean Lebrun. Pp. 90+6 plates. Exploration du Parc National Albert—Mission J. de Heinzelin de Braucourt (1950). Fascicule 1: Le Fossé Tectonique sous le Parallèle d'Ishango. Par Jean de Heinzelin de Braucourt. Pp. 150+8 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1955.) [127

Tanganyika. Annual Report of the Geological Survey Department, 1954. Pp. v+32. (Dar-es-Salaam: Government Printer, 1955.) Shs. 2/50.

Republic of Egypt. Ministry of Commerce and Industry: Mines and Quarries Department. Geological Survey. Geology of Abu Diab District. By Dr. M. S. Amin and G. A. Moustafa. Pp. x+42+18 plates. P.T. 125. Deposits in the Nile Valley and the Delta. By M. I. Attia. Pp. xiv+356+plates 1–71 and A–E. P.T. 150. Mineral Resources Department. Paper No. 1: Contributions to the Mineralogy of the Copper Deposits in Sinai. By Dr. E. M. El Shazly, S. Abdel Naser and B. Shukri. Pp. vi+13 (5 plates). P.T. 10. (Cairo: Government Press, 1954 and 1955.) [127

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Centro Brasileiro de Pesquisas Fisicas. Notas de Fisica. No. 16: Invariance of Field Theory Under Time Inversion. By J. Tiomno. Pp. 24. No. 18: Equacao de Proca em Coordenadas Esfericas. By Samuel Wallace MacDowell. Pp. 9. No. 19: Mass Reversal and the Universal Interaction. By J. Tiomno. Pp. 11. No. 20: On the Mechanism of Fission at Very High Energy. By Luis Marques. Pp. 2. No. 21: A Casual Interpretation of the Pauli Equation (A). By D. Bohn, R. Schiller and J. Tiomno. Pp. 28. (Rio de Janeiro: Centro Brasileiro de Pesquisas Fisicas, 1954.) [127

World Health Organization. Monograph Series No. 6: Cardiolipin Antigens: Preparation and Chemical and Serological Control. By Dr. Mary C. Pangborn, Dr. J. O. Almeida, Dr. F. Maltaner, Dr. A. M. Silverstein and Dr. W. R. Thompson. Pp. 52. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 4 Swiss francs; 6*s.* 9*d.* net; 1·25 dollars. [127

Uganda Protectorate. Annual Report of the Forest Department for the year ended 31st December, 1954. Pp. ix+53+4 plates. (Entebbe: Government Printer, 1955.) 3*s.* [127

Berichte des Deutschen Wetterdienstes. Nr. 18 (Band 3): Die Thermodynamik der Taubildung. Von Gustav Hofmann. Pp. 45. (Bad Kissingen: Deutschen Wetterdienstes. 1955.) [127

Hypothèses sur l'Homme. Par Boris Rybak. Pp. 12. (Poitiers: Imprimerie Victor-Hugo, 1955.) [157

Acta Psychiatrica et Neurologica Scandinavica. Supplementum 99: Induced Abortion on Psychiatric Grounds: a Follow-up Study of 479 Women. By Martin Ekblad. (Translated by Donald Burton.) Pp. 238. (Copenhagen: Ejnar Munksgaard, 1955.)

Smithsonian Miscellaneous Collections. Vol. 128, No. 1: Amphipoda Collected at the Arctic Laboratory, Office of Naval Research, Point Barrow, Alaska, by G. E. MacGinitie. By Clarence R. Shoemaker. Pp. i+78. (Publication 4209.) (Washington, D.C.: Smithsonian Institution, 1955.) [157

Polska Akademia Nauk: Komitet Astronomi. Acta Astronomica. Ser. B, Vol. 2, Pp. 134–169: The Eclipsing Variables Y Cam, FH Ori, Z Per and the Variations of their Periods. By A. Szczepanowska. (Warszawa: Polska Akademia Nauk, 1955.) [157

South African Institute for Medical Research. Annual Report for the year 1954. Pp. 106. (Johannesburg: South African Institute for Medical Research, 1955.) [187